Materials
in Design Engineering

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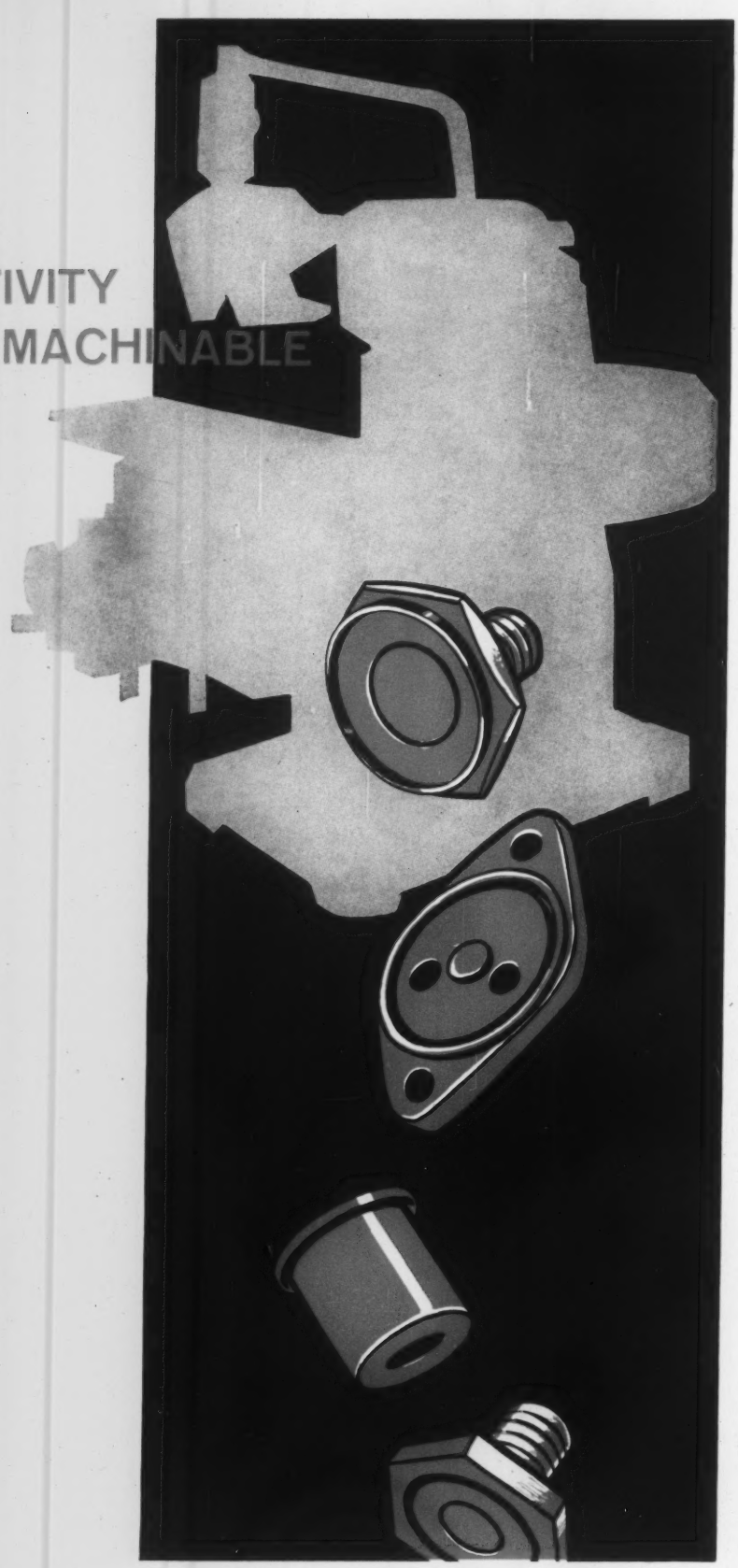
MATERIALS ENGINEERING

AUGUST 1961

THESE TOUGH, HIGH-CONDUCTIVITY COPPERS ARE MACHINABLE



A semi-conductor base is a typical application of electrical copper demanding—

- strength to withstand high torque,
- high thermal conductivity,
- machinability.

Ideal for such requirements are these five alloys from Anaconda:

DLP Copper-104 (deoxidized low phosphorous)

OFHC* Copper-120 (oxygen-free high conductivity)

Tellurium Copper-127

Chromium Copper-999

Amzirc* (Zirconium Copper)-134

Each of the above provides a slightly different combination of desirable properties, and all can be machined as required to achieve necessary accuracy and maintain reasonable production costs.

Anaconda Specialists can help you select the right alloy and form of metal—and the manufacturing method best suited to meet your design and fabrication problems. They can help you utilize cost-cutting techniques, such as roll threading of studs, and advise you on welding and brazing procedures. Whatever your problems, Anaconda offers specialized technical help.

Anaconda Publication C-34 provides useful data on composition, typical physical and mechanical properties, forms available, and fabrication methods. For this publication, or technical assistance in applying these electrical coppers, address: Anaconda American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 61-816

*Trade-marks of American Metal Climax, Inc.

ANACONDA
AMERICAN BRASS COMPANY

For more information, turn to Reader Service card, circle No. 354

AUGUST, 1961 | VOL. 54, NO. 2

Materials in Design Engineering®

FORMERLY MATERIALS & METHODS

APPLICATION OF METALS, NONMETALLICS, FORMS, FINISHES

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What's New in Materials

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Flexible plastic has no plasticizers to volatilize or migrate

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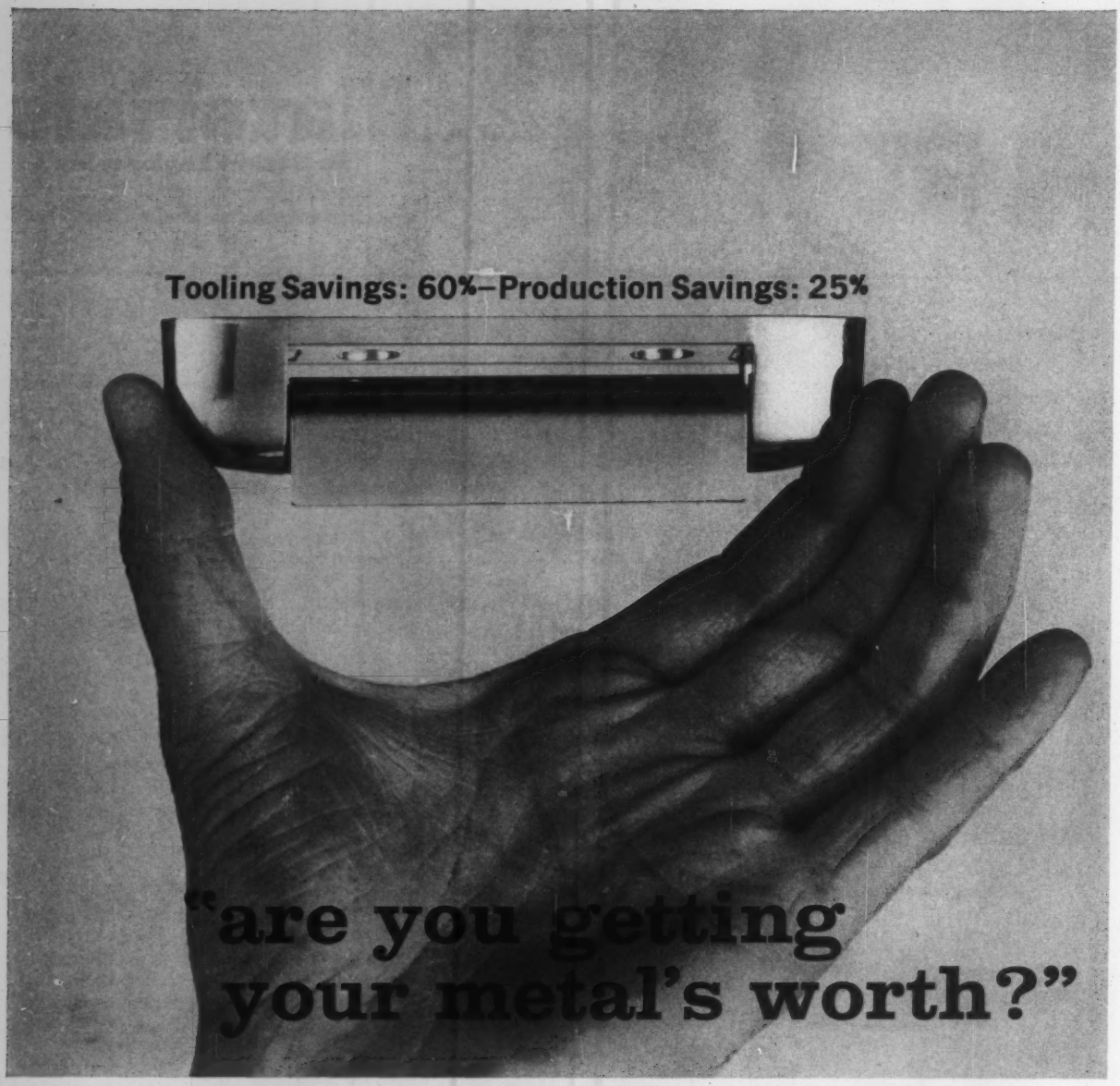

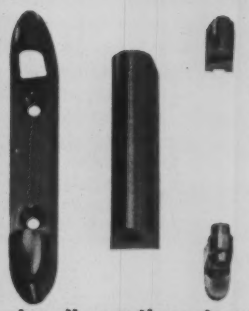

If time and money were no object, you could assemble this refrigerator door hinge from a steel stamping, a brass stamping, screw machine parts and just one die casting. Then you could keep busy with some tricky operations necessary to attach the hinge halves – drilling blind holes accessible only with an angle drive drilling head and staking steel pins in the holes.

However, Die Cast Products, Inc. of Gardena, California prefers the 60% reduction in tooling costs and the 25% drop in production costs achieved by a unique design using four zinc die cast components which are cast in one shot and trimmed in one operation. That way they are faced with no other secondary operations before plating – and assembly is simple.

To find out how to put zinc die castings to work for you, see your nearest die caster for information about their properties, use, design techniques and machining practices. REMEMBER – ZAMAK GIVES YOU MORE FOR LESS. ARE YOU GETTING YOUR METAL'S WORTH?

NJZ

HORSE HEAD PRODUCTS

THE NEW JERSEY ZINC CO.
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For more information, turn to Reader Service card, circle No. 404

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Faster, Less Expensive Creep Data

Low Friction Coatings with Good Bond Strength

Ultra High Pressures Create New Materials . . . An exclusive roundup on a new technology. How pressures up to 3,000,000 psi may lead to new materials and improved properties.

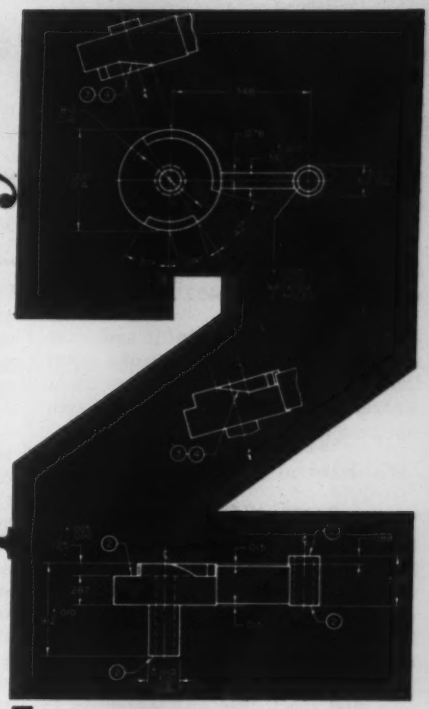
Thin-Film Electronic Components

Five Malleable Castings Cut Costs

How Materials Are Used in the Mercury Capsule

This Month's Cover *by Wayne Trapp. Pattern is enlargement of "Oxford" textured steel sheet produced by Ardmore Products, Inc., Roselle, N. J.*

blueprint for



The blueprint shown above is for a phonograph motor toggle link pressed from brass powder by American Powdered Metals Inc. for the General Industries Company. Why blueprint for two? Because it combines 2 design functions—structural support and cam surface—in a single part. Because powder metallurgy is the only economically practical way to make this part—and it could not have been achieved without design teamwork between the customer and the metal powder fabricator.

Teamwork produced a precise, intricate part assuring exact turntable speed and providing a cam surface which controls speed selection. The cam surface must be smooth and accurate—and stay that way. Holes must parallel and round to within .0005" total indicator reading. Hole centerlines must be parallel to each other within .002" T.I.R. Brass powder supplies the properties necessary for these requirements with its ideal combination of structural strength and self-lubrication.

Working together, the metal powder fabricator and design engineer make economical mass production of critical parts a reality. And we also mean "critical" in the sense that a whole is no better than the quality of its most prosaic part. For more information about the design, application and advantages of nonferrous metal powder parts, write today to The New Jersey Zinc Company for your copy of "Designing For Pressed Brass and Nickel Silver Parts."

HORSE HEAD® ATOMIZED NONFERROUS METAL POWDERS ARE PRODUCED BY
THE NEW JERSEY ZINC COMPANY
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DEVELOPERS OF BRASS & NICKEL SILVER POWDERS SETTING TODAY'S STANDARDS

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How to choose a metal for sub-zero service

What metal do you use in equipment for sub-zero studies in chemistry and physics... in pressure vessels and auxiliary equipment for storage of ethylene at −155°F... in tanks and ocean-going barges that must handle liquefied gases at −258°F... in storing and piping equipment for liquid nitrogen at −320°F or liquid helium at −452°F?

Just any metal won't do: in each case the equipment must be made of a metal that retains its toughness where other metals embrittle in crippling sub-zero temperatures.

Which metal to use... and where?

2¼% NICKEL STEEL

For moderately low temperature service, this nickel steel offers a combination of good mechanical properties and superior resistance to brittle fracture at temperatures down to −75°F. 2¼% nickel steel may be found at work in refrigeration equipment, cooling apparatus, and machinery and structures in very cold climates.

Design Data

ASTM A-203 Grade	Tensile Strength psi, min.	Yield Strength psi, min.	Allowable Tensile Design Stress ASME, psi, max.
A	65,000	37,000	16,250
B	70,000	40,000	17,500

Welding Materials: For manual metal-arc welding, use low hydrogen coated electrodes of the E8015-16-18 C1 Classification conforming to AWS-ASTM specification A316. These electrodes will deposit a weld metal of essentially base metal composition.

3½% NICKEL STEEL

Low carbon 3½% nickel steel has both high strength and a resistance to brittle fracture which has led to its use as a standard material for pressure vessels operating at temperatures down to −150°F − vessels for manufacturing, storing and transporting liquefied hydrocarbons. It is also widely used in aircraft testing units and equipment for oil refinery processes.

Design Data

ASTM A-203 Grade	Tensile Strength psi, min.	Yield Strength psi, min.	Allowable Tensile Design Stress ASME, psi, max.
D	65,000	37,000	16,250
E	70,000	40,000	17,500

Welding Materials: For manual metal-arc welding, low hydrogen type electrodes of AWS-ASTM Classification E8015-16-18 C2 will deposit weld metal containing not over 0.10 carbon and 3% to 3½% nickel.

9% NICKEL STEEL

Low carbon 9% nickel steel provides an excellent combination of strength and notch toughness at temperatures down to −320°F. Specifically developed to meet engineering demands for an economically priced metal for low temperature service, this material is produced in the quenched and tempered or double normalized and tempered conditions. Operation Cryogenics has demonstrated that this material may be used safely even without thermal treatment after welding. At the present time an ASME code case is being prepared to use pressure vessels made of either of these conditions, omitting the post-weld heat treatment. 9% nickel steel is at work in equipment handling such products as liquid methane at −258°F, oxygen at −297°F, and nitrogen at −320°F.

Design Data

ASTM A-353 Grade	Tensile Strength psi, min.	Yield Strength psi, min.	Allowable Tensile Design Stress ASME, psi, max.
A	90,000	60,000	22,500
B	95,000	65,000	23,750

Welding Materials: Best results are obtained with Inco-Weld* coated electrodes or wire of a high nickel-chromium-iron composition. Inco-Weld "A" electrode is used for manual welding, and Inco-Weld "A" wire is used for inert gas welding with tungsten electrode or inert gas-metal arc welding.

304 NICKEL STAINLESS STEEL

Types 304 and 304L nickel stainless steels are very well-suited for service at extreme sub-zero temperatures down to −452°F, the temperature of liquid helium and the lowest measured service temperature. These nickel stainless steels are widely used in low temperature service because they are easy to fabricate, do not require heat treatment after fabrication, and have high strength with superior ductility and shock resistance at very low temperatures. And because of their corrosion resistance, nickel stainless steels are employed wherever high product purity and ease of cleaning following fabrication are essential − as in the handling of missile propellants. In fact, for optimum *corrosion resistance* at *any* temperature in the sub-zero range, nickel stainless steels are the best choice.

Design Data

ASTM A-240 Grade	Tensile Strength psi, min.	Yield Strength psi, min.	Allowable Tensile Design Stress ASME, psi, max.
304	75,000	30,000	18,750
304L	70,000	25,000	17,500

Welding Materials: For metal-arc welding, use coated austenitic stainless steel electrodes conforming to AWS Classification E308 ELC-ASTM A298. Inert gas-metal arc welding requires ER308L wire conforming to ASTM A371.

Cold Facts on Metal Economy

Interestingly enough, the nickel alloy steels increase significantly in strength as the temperature is lowered into the sub-zero range. For example, 9% nickel steel has a tensile strength at room temperature of 105,000 psi; at −320°F its tensile strength is 165,000 psi.

The high room temperature tensile properties of these nickel alloy steels which manifest themselves in higher code design strengths makes it possible to use thinner, more economical sections with complete safety. As the structure is cooled to its sub-zero operating temperature, the characteristic response of the nickel steels − an increase in strength while still maintaining toughness − further confirms the wise selection of these steels in sound engineering design.

LITERATURE

The publications listed below are especially recommended for guidance in selecting metals for sub-zero service.

Publication Number	Name
A269	Properties of Nickel Steel Plates at Low Temperatures
A263	9% Nickel Steel for Low Temperature Service
A278	3½% Nickel Steel for Low Temperature Service
A273	2¼% Nickel Steel for Low Temperature Service
	Operation Cryogenics
A276	Steels for the Containment of Liquefied Gas Cargoes

A complete listing of Inco publications and technical bulletins can be obtained by writing for "List A" to:

*Registered trademark.

The INTERNATIONAL NICKEL COMPANY, Inc.

67 Wall Street INCO New York 5, N. Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

For more information, turn to Reader Service card, circle No. 335

A new stainless steel with greatly improved weldability is now commercially available. Substantial manganese in the steel is said to decrease its hot cracking tendencies and thereby increase weldability. In addition to manganese, the steel contains chromium, molybdenum, nickel, silicon and carbon. It is sold as plates, sheets, forgings and bars, and is also available in the form of investment and shell mold castings.

Source: Westinghouse Electric Corp., Materials Mfg. Dept., P. O. Box 128, Blairsville, Pa.

A new thermal insulation withstands temperatures up to 2300 F. The insulation consists of a silico-alumina compound sandwiched between two metal skins or between a metal skin and a fiberglass laminate. It is custom designed and molded onto customer-furnished metal or ceramic parts.

Source: Olympic Plastics Co., Inc., 3471 S. La Cienega Blvd., Los Angeles 16.

A new FEP fluorocarbon resin is designed especially for injection molding such complicated parts as coil forms, electronic insulators, seals and bushings. Easier to mold than general-purpose FEP resins, the new grade is said to permit fabrication of parts having thinner cross sections with improved quality.

Source: E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

High purity molybdenum wire for spray metallizing and plasma arc applications is now available in diameters ranging from 0.057 to 0.125 in. Supplied in continuous length coils, the wire is said to fit all popular spray and plasma arc guns.

Source: Wah Chang Corp., 233 Broadway, New York 7.

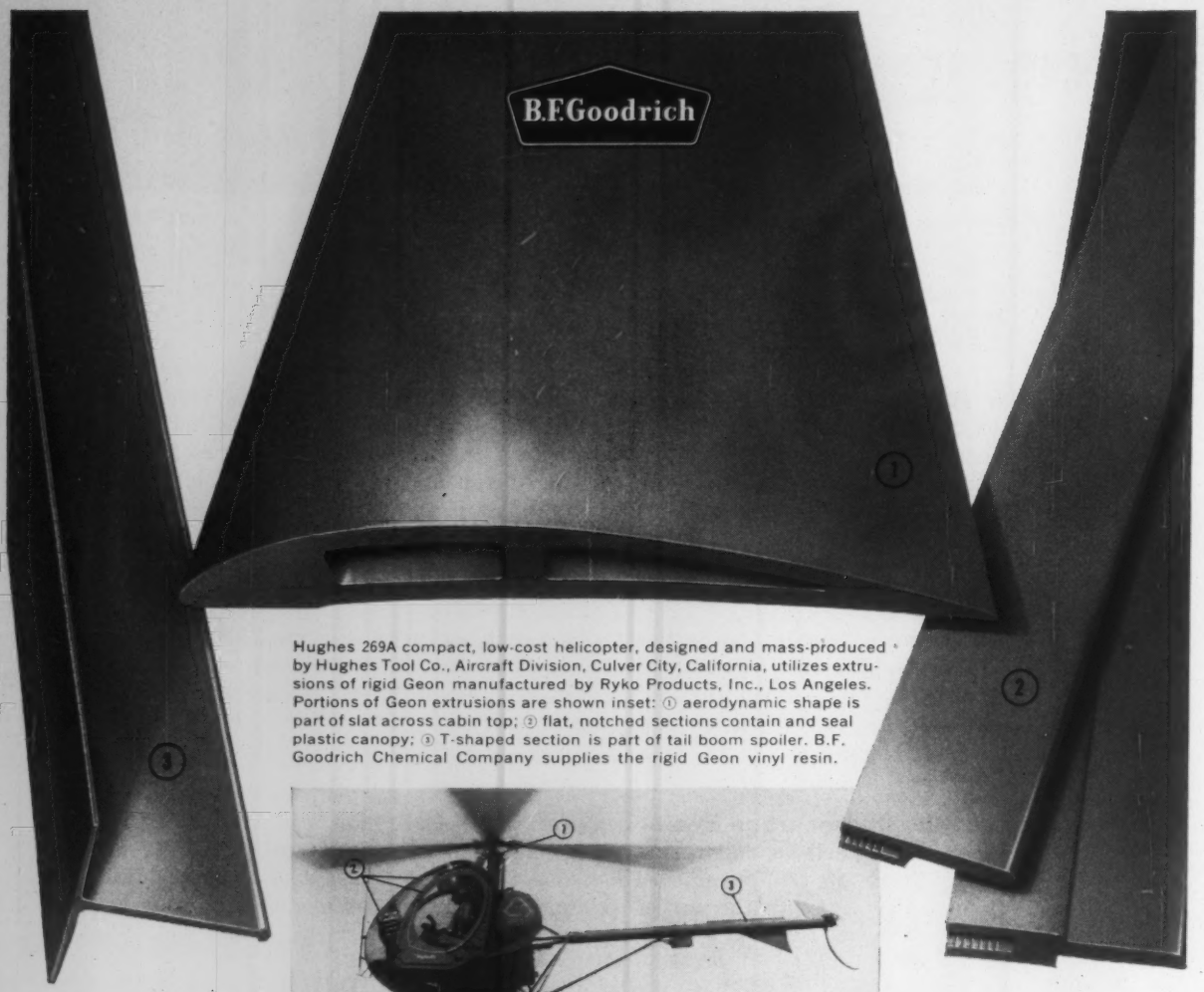
A new dry film lubricant can be used from –300 to 1200 F. Described as an inorganic bonded material, the lubricant is insensitive to liquid oxygen, has good radiation resistance, and retains its lubricating properties under high vacuum. The lubricant air-dries to a tough, resilient coating in 1 hr at room temperature.

Source: Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn.

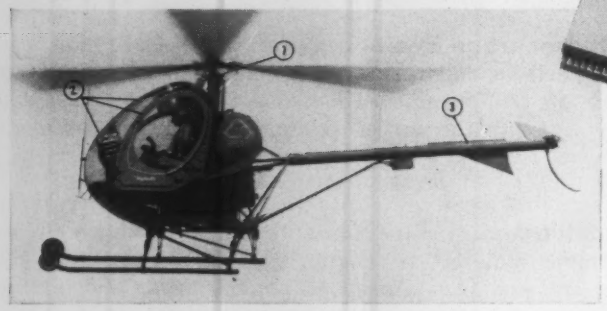
A potential high temperature structural material for use in missiles, rockets and satellites is a thermosetting plastic reinforced with beryllium oxide fibers. Preliminary investigations show the fibers have tensile strengths up to 2 million psi. Melting point is 4650 F.

Source: National Beryllia Corp., Haskell, N.J.

One of phenolic resin's biggest drawbacks—poor flexibility—has apparently been overcome with the introduction of a new phenol that is said to permit internally plasticized, permanently flexible phenolic resins. Other advantages are: a 35% increase in impact strength, lower specific gravity, excellent preheatability, superior



Hughes 269A compact, low-cost helicopter, designed and mass-produced by Hughes Tool Co., Aircraft Division, Culver City, California, utilizes extrusions of rigid Geon manufactured by Ryko Products, Inc., Los Angeles. Portions of Geon extrusions are shown inset: ① aerodynamic shape is part of slat across cabin top; ② flat, notched sections contain and seal plastic canopy; ③ T-shaped section is part of tail boom spoiler. B.F. Goodrich Chemical Company supplies the rigid Geon vinyl resin.



Now even helicopters go "compact"– low-cost design features rigid Geon

The manufacturer of this helicopter had a special design problem: how to save weight and cost while meeting the tough design requirements of aircraft. Engineers found the answer in rigid Geon vinyl. Lightweight and accurate extrusions of rigid Geon helped keep costs down. At the same time, their strength and resistance to weathering made them structurally and aerodynamically ideal.

Rigid Geon vinyl extrusions are used to join—and seal—sections of the acrylic "bubble", as well as for door frame retainers. Other extrusions form the aerodynamic slat across the cabin top and the tail boom spoiler.

Here's another excellent example of the way that rigid Geon improves a product, reduces weight and costs. To get more information, write Department NN-6, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. In Canada: Kitchener, Ontario.

B.F.Goodrich Chemical

a division of The B.F.Goodrich Company

Geon VINYLS

REG. U.S. PAT. OFF.

For more information, turn to Reader Service card, circle No. 435

flow characteristics, and a 30% increase in flexural strength. Resins made with the new phenol are expected to be used in laminates, varnishes and molding compounds.

Source: Koppers Co., Inc., Tar Products Div., Koppers Bldg., Pittsburgh 19.

A promising system for protecting molybdenum at 2000-2500 F for 50 to 100 hr is aluminum oxide flame sprayed over a chromium electroplate. A system for protecting columbium under the same conditions is glass-impregnated aluminum oxide applied by flame spraying. Still far off: a protective system for temperatures over 3000 F.

Source: Battelle Memorial Inst., 505 King Ave., Columbus 1, Ohio.

A new heat reflective tape can be used continuously at temperatures up to 600 F and can withstand radiant heat above 3000 F for short periods. The highly reflective tape is a lamination of 0.0005-in. thick aluminum foil to 0.002-in. thick glass cloth that has been coated with a silicone adhesive. The tape is recommended for protecting electrical control cables, wire circuits, piping, pump valves and motors.

Source: Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Look for stronger lead alloys to come out of current research. Lead-copper alloys have been made that have tensile strengths up to 8000 psi, elongations up to 20%, and creep strengths approximately seven times that of the best lead alloys now available. The new alloys also have very good corrosion resistance, about the same as that of chemical lead. Pilot plant production of sheet, pipe, tubing and cable sheathing of these alloys will be started this year.

Source: Lead Industries Assn., 60 E. 42nd St., New York 17.

Two new polyethylene compounds have been designed for insulating wire and cable. The two polyethylenes differ from other thermoplastic insulating compounds in that they are chemically crosslinked when exposed to heat. Crosslinking is said to greatly improve dimensional stability of the compounds and eliminate stress cracking. One compound is recommended for use on high voltage cable and the other for line wire.

Source: Union Carbide Plastics Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17.

A repair compound for bronze and brass castings hardens without heat or pressure, and can be drilled, ground and machined. Appearance after machining is said to be similar to that of bronze. The new compound is unaffected by oil, water and most chemicals, according to the developer. Shrinkage during hardening is 0.0005 in. per in.

Source: Devcon Corp., Danvers, Mass.

Bright, corrosion resistant aluminum parts can be obtained by electroplating nickel and chromium over metal that has been anodized, recent research shows. The new method is cheaper than conventional zincate methods, and does not cause galvanic attack on the basis metal when a copper strike is used.

Source: Kaiser Aluminum & Chemical Corp., Dept. of Metallurgical Research, Spokane, Wash.

SALES MAKERS...

Blister Packages of Butyrate Sheet

Shoppers for tools are like shoppers for most things... they reach for merchandise that's quality-packaged to stay factory-new, and clearly displayed for a close look—important factors in self-service. With this thought in mind, Fuller Tool Company began blister-packaging its pliers in sheet extruded of Tenite Butyrate... and sales almost doubled.

Tough and resilient, blisters formed from sheet of Butyrate protect as they display. They are easily assembled to cardboard or other backing by flange-fit, as in the "Slideplax" package for pliers, or by heat-sealing or stapling.

In use, sheet made from Tenite Butyrate has exceptional resistance to impact and its gleaming luster stands up under repeated handling. Butyrate in special formulations also has excellent weather resistance—a factor in the expanding use of the sheet for outdoor signs.

With this array of service properties, sheet extruded from Tenite Butyrate can often be used in thinner gauges than other materials. Economical thermoforming will shape it to intricate detail. And more than 42,000 colors and color effects in Eastman's plastics color laboratory are ready to add extra eye-appeal.

You can get valuable aid in applying Butyrate sheet to your product ideas from an Eastman technical representative. Or, for some helpful literature on the uses of sheet made from Tenite Butyrate, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

TENITE®
BUTYRATE
an Eastman plastic

Pliers manufactured by Fuller Tool Co., New York 67, N. Y.; blister-packaged in sheet of Tenite Butyrate extruded by Joseph Davis Plastics Co., Kearny, N. J., and thermoformed by Plaxall Inc., Long Island City, N.Y.

***Flexibility** is demonstrated by turning injection molded box inside out. Also note slip-fit tubing at left.*

***'Hand' and elasticity** of film make new plastic promising for textile applications.*

More competition for PVC . . .

A New Ethylene Copolymer

needs no plasticizer, and can be loaded with low cost fillers.

■ A new ethylene copolymer material, with excellent low temperature flexibility and elasticity has been announced by Spencer Chemical Co., Dwight Bldg., Kansas City 5. It contains no plasticizers, thus eliminating problems of migration or volatilization.

Apparently the material is quite similar to the ethylene-ethyl acrylate copolymer materials recently announced by Union Carbide Plastics Co. (see M/DE, May '61, p 14), and Dow Chemical Co. According to Spencer, one of the most important differences its material exhibits is the ability to be heavily loaded (up to about 50%) with low cost fillers without appreciably affecting tensile strength or elongation.

Called Poly-Eze, the material has properties similar to those of low density polyethylene, but is reported to have improved flexibility, impact strength and resistance to stress cracking.

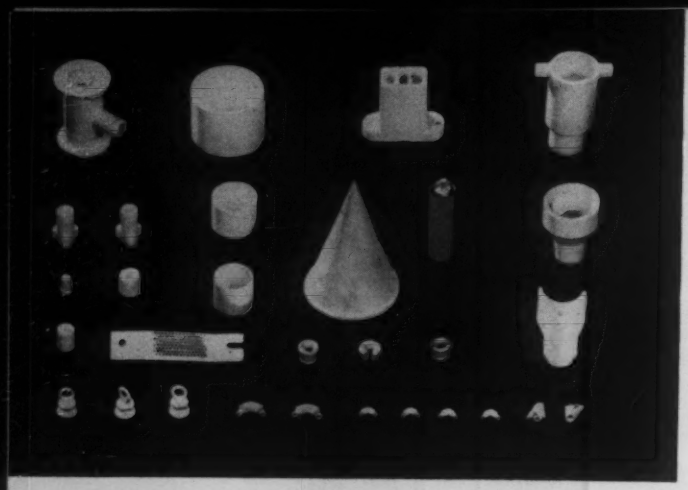
Moldings, sheet, extrusions

Spencer is now investigating applications for the material in products made by injection and blow molding, and in the form of extruded film, tubing and sheet.

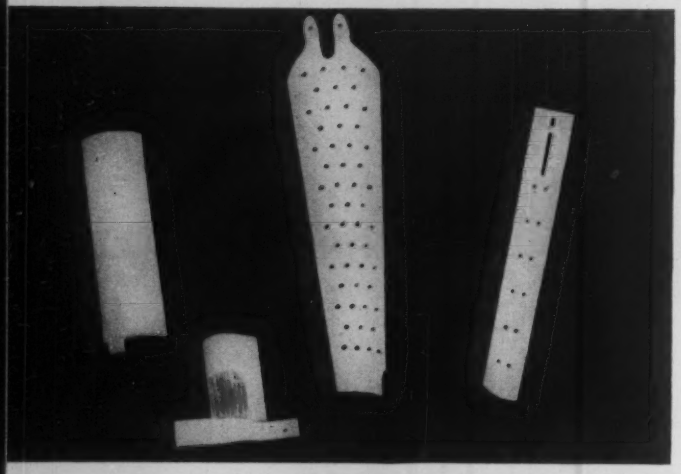
Injection molded, it may find uses as swim fins, notebook covers, and other parts requiring flexibility. Blow molded it may be used for toys, dolls, syringes, and parts such as bellows.

In the form of film or sheet, the material may find uses as tablecloths, draperies, shower curtains, tapes, tank liners, inflatables and other film applications where vinyl plasticizer migration could be a problem. As extruded tubing, the material's elasticity permits tight slip fits; low temperature flexibility makes the material suitable for gaskets and refrigerator parts.

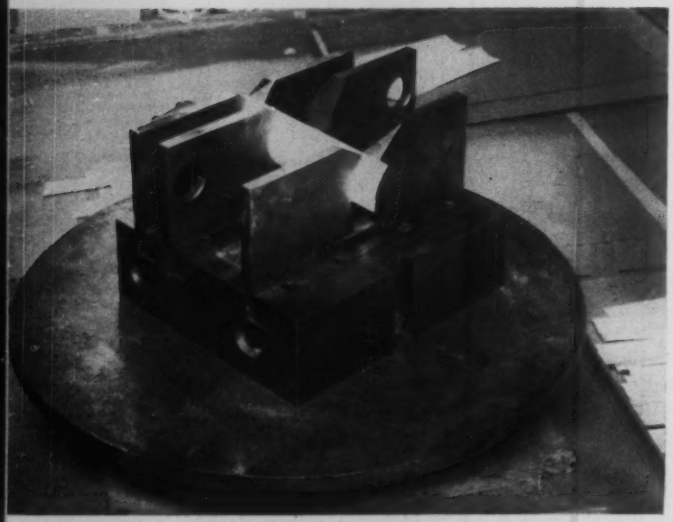
For more information, circle No. 600



• **Variety of compositions,** *including titanium dioxide, forsterite, zircon, spinel and barium titanates for electrical, mechanical and other parts.*



• **Highly complex shapes,** *such as these leachable cores for hollow cast jet turbine blades.*



• **Close tolerances.** *Here a three-point guillotine gage is used to check jet engine blade cores.*

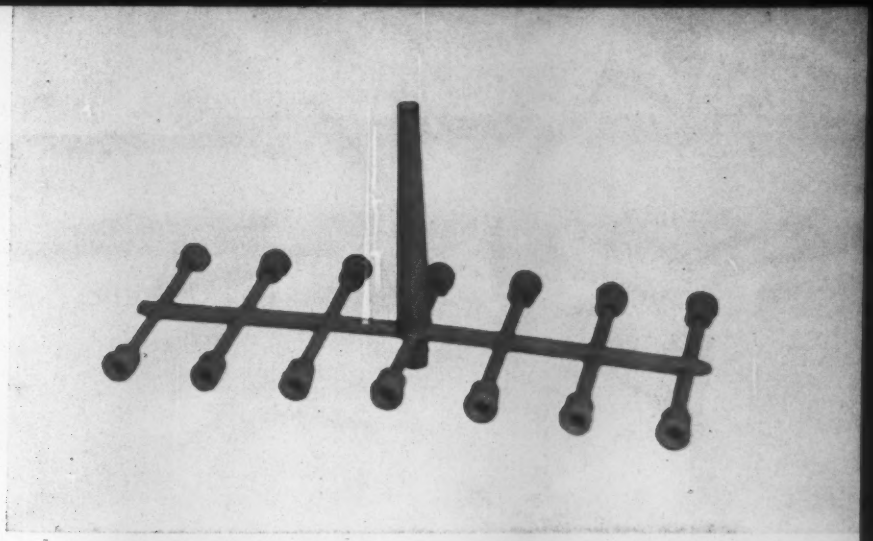
Injection Molded Ceramics

Now for the first time with ceramics it is possible to take full advantage of the economies offered by this high speed process.

by R. L. Randolph, *Ceramic Engineer, American Lava Corp.*

■ Thread guides for textile machines used to be machined one at a time from titanium dioxide—now 14 of them are injection molded in one shot. The only subsequent work consists of one machining operation, firing, and drum finishing; multiple machining and hand polishing are eliminated.

This is one example of what injection molding, the high speed, automatic process used for making thermoplastics parts, can mean in reducing the cost of a ceramic part. Although injection molding of ceramics is not new in itself (e.g., spark plug insulators were produced in this fashion some years ago), we believe this is the first time that it has been possible to produce a wide range of ceramic compositions by this method economically and in large



Multi-cavity production, *one of the basic benefits of injection molding, is typified by these 14 titanium dioxide thread guides.*

quantities in other than relatively simple shapes.

Five benefits stand out

Injection molding offers five major advantages for ceramics:

1. Automatic molding in multi-cavity molds can substantially reduce per-part cost.

2. The method of filling the mold permits production of parts more complex in shape than would be considered economically possible in large quantities by other methods.

3. Part-to-part reproducibility of dimensions is greater than that obtainable economically by machining.

4. Molded surfaces are smoother than extruded or machined surfaces.

5. The injection molding process uses mixtures of materials (ceramics, thermoplastics and oils) that are less sensitive to such process variables as moisture and humidity than the mixes used in traditional dry pressing and extruding; consequently closer tolerances are possible. Standard tolerances are ±1% of the fired dimension.

Many compositions moldable

More than a dozen ceramic compositions have been injection molded by American Lava over the past three years with consistent success. These include aluminas, titanium dioxide, forsterite, zircon, spinel, barium titanates and various alkali-leachable ceramics.

Such materials can be injection molded to meet both mechanical requirements, (for thread guides, appliance parts, nose cones, cores for castings, etc.) as well as electrical and electronic requirements (for radomes, capacitors, switch parts, etc.).

Design limitations

The parts shown in the accompanying photos indicate the complexity of shape possible with the process. The mixture of ceramic, plastics and oil used can be varied to control shrinkage, overcome difficult flow problems in molding thin sections, and improve handling characteristics. But there are important limitations to keep in mind.

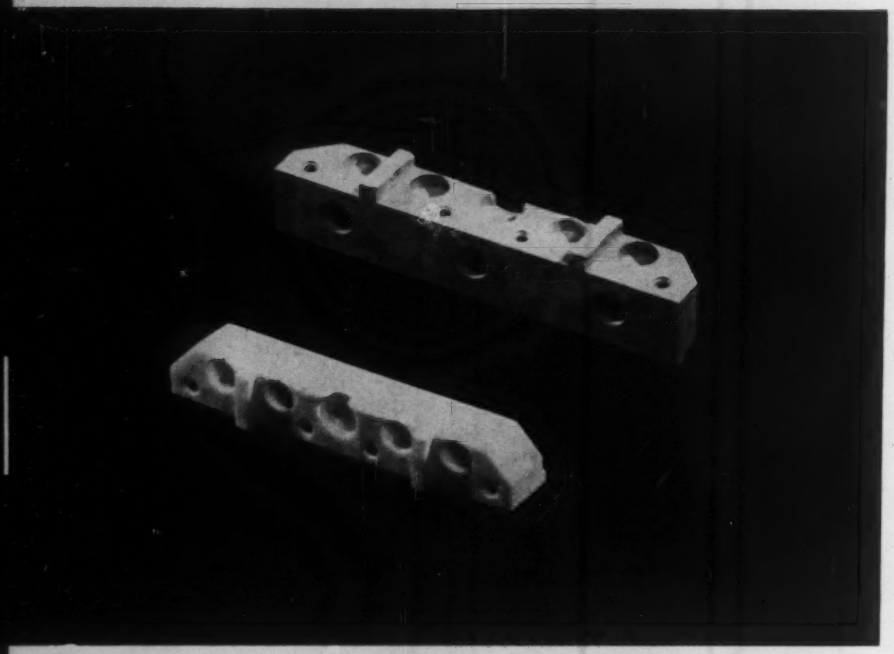
Although a fragile, thin, curved section, such as an airfoil-shaped core for a jet engine turbine blade, may be relatively easy to mold, it still must be fired. If the ceramic tends to slump during firing, the part may need special "setters," or supports, in the kiln. Such setters are often costly, as they may be nearly as complex as the part itself.

In designing a part, remember that the same tapers, parting lines, gate marks and ejector pin marks encountered with injection molded plastics parts are necessary for ceramics. Also, the shrinkage of ceramics during firing is usually much greater than the post-mold shrinkage of plastics. Ceramic shrinkage may range from 2 to 21%, depending on composition. Consequently, ceramic parts cannot be produced to size with molds designed for thermoplastics.

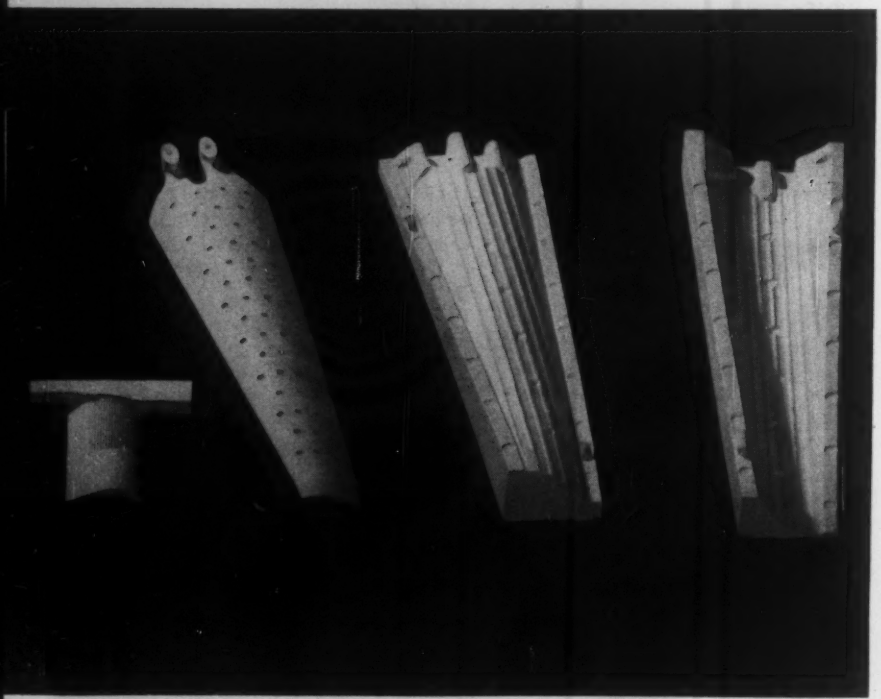
This shrinkage, as well as other design factors, makes it critical for designers to consult the ceramics molder in the initial design stages. For example, in general when the heaviest section of a part exceeds ¼ in. the part is difficult to mold and fire properly. Consequently, before freezing the design it may be desirable to incorporate such compensating features as grooves, holes or depressions to reduce sections.

On the other hand, parts with sections that are too thin and parts with deep draws tend to slump during firing. Although no unusual difficulty is experienced in molding sections as thin as 0.020 in., the shape must either support itself or be externally supported in the kiln. Such thin sections should be limited to 4.5 sq in. or less to prevent flow problems during molding.

Accurately estimating the number of parts you will need prior to mold design and construction can save you money. Design and construction of the mold takes about six weeks. In most cases the first cavity is the most expensive. Additional cavities can be



High ceramic shrinkage *is shown graphically by difference between "green" as-molded part at top and same part fired at bottom.*



Thin sections *may need setters. Two thin leachable cores used in casting hollow jet turbine blades are shown at left. Firing the larger one requires setters (right) almost as complex as the core itself.*

produced at a lower cost per cavity while the moldmaker is still set up on the first cavity. Also, injection molding machines, as well as the molds, provide their maximum economies on long runs, since the same set-up time is required for a short run as for a long one.

How the process works

Ceramic materials to be injection molded are carefully weighed, mixed and ball milled to insure homogeneity and uniformity of particle size from batch to batch. The ceramic is then combined with thermoplastic resins and oils. These are carefully selected on the basis of melting points, molecular weights and ash contents, and then matched with the particle size and bulk density of the ceramics.

The oils serve a dual purpose: they lubricate the mix during injection, and they build porosity to permit removal of all volatiles during firing. An orderly sequential volatilization of the nonceramic ingredients is necessary to prevent distortion of the part during firing. For example, the light oils which vaporize first do so slowly, producing a slight porosity that speeds the removal of the next oil to volatilize. The plastics are the last in the chain of volatiles to bake out.

Near the end of this distillation process, it is halted to leave a small amount of resin in the part for green strength sufficient for handling, grinding or machining prior to final firing. The final firing volatilizes all the remaining additives. This process of baking out volatiles may require as long as eight days, depending on the mass of the formed part.

Injection molding machines are hopper-fed and automatically controlled by time-cycle relays. The baking-out process takes place in an electrically heated, program-controlled oven. Final firing is done in the same kilns used for firing other types of formed ceramic parts. Firing temperatures range from 1200 to 3100 F, depending on the type of ceramic.

For more information circle No. 601

Costs Cut in Precision Casting Process

Reclaimable mold materials, reduced preparation time improve economics of Shaw process.

■ A composite mold consisting of a low cost sand backing with a special ceramic facing has been developed as a substitute for the solid ceramic mold previously used to produce castings by the Shaw process. Details of mold production are shown in the accompanying series of drawings.

At the same time, Shaw process engineers have developed an automatic molding machine that will produce 120 molds per hr. They believe that the introduction of automation will facilitate production of thin-walled precision castings of ferrous metals that are comparable with die castings in accuracy, section thickness and surface finish.

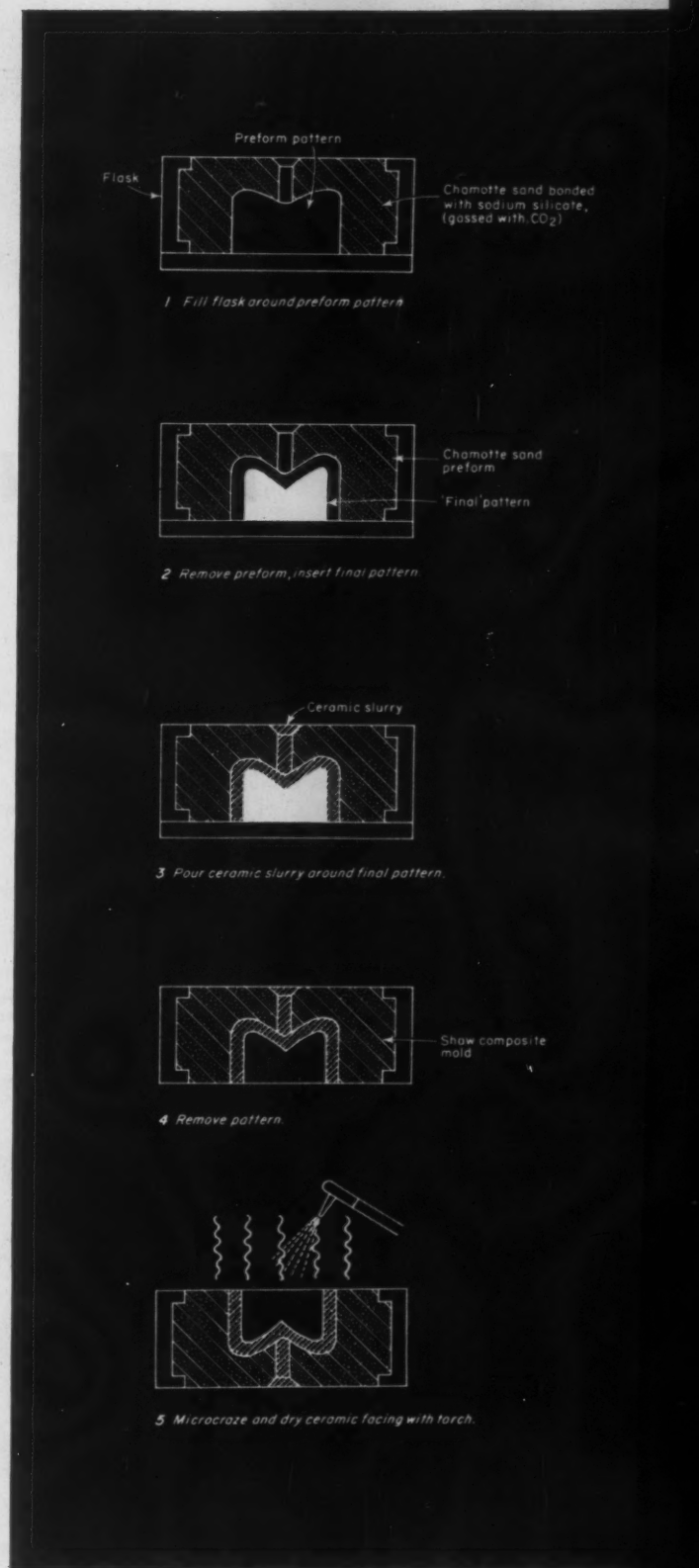
Time, cost reduced

The new mold offers the engineer and designer two features that should contribute to reduced casting costs.

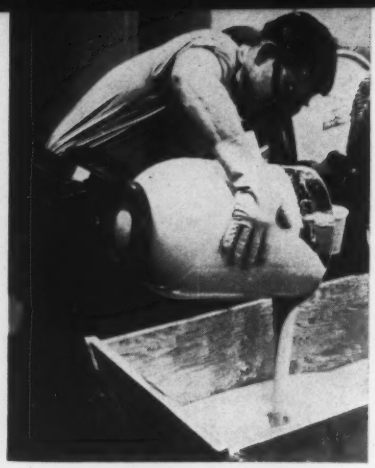
▸ Virtually all of the backing and ceramic facing can be reclaimed after the mold is broken to free the casting. Since the ceramic mold interface does not permit burn-in of the molten metal, reclamation is close to 100%.

▸ Elimination of the solid ceramic mold reduces the "bakeout" period needed to burn off volatiles in the ceramic mix from 4 to 5 hr to approximately 5 min. Reduction in time needed to burn off volatiles, in turn, makes automation of the process feasible. Automation of the previously used solid ceramic mold would have required the use of large industrial ovens; reducing the ceramic to a thin layer over a sand backing permits the use of gas torches in the volatilization step.

For more information circle No. 602


Preform pattern
Flask
Chamotte sand bonded with sodium silicate, (gassed with CO_2)
1 Fill flask around preform pattern.
Chamotte sand preform
Final pattern
2 Remove preform, insert final pattern.
Ceramic slurry
3 Pour ceramic slurry around final pattern.
Shaw composite mold
4 Remove pattern.
5 Microcraze and dry ceramic facing with torch.

Postformable foam—*Spacers of cured foam shown here have been warmed, formed to shape and bonded to aluminum hemisphere. Pour-in-place system is being brushed on to fill voids between spacers.*



***Foam-in-place** systems. Large slab shows mass that can be poured without burnout or charring.*

Three New Epoxy Foams

for structural and electrical uses

by M. R. Pollock and H. K. Zahn, *Engineers, Wichita Div., The Boeing Co.*

■ A new family of improved rigid epoxy foam materials offers excellent structural and electrical insulating characteristics, combined with ease (and versatility) of handling, and consistent and reproducible quality.

The three types are:

1. Two liquid pour-in-place systems, one limited to temperatures below 250 F, the other for use at slightly higher temperatures.

2. A powdered foam for strength at temperatures up to 500 F.

3. A postformable system which, after cure, softens when heated so that it can be formed easily to complex contours.

All have closed cell structures, although the formable type can be produced with open cells.

(For another new epoxy foam —a fluorocarbon-blown thermal insulating foam—see M/DE, Mar '61, p 120.)

The three types have high tensile, flexural and compressive strengths, excellent dimensional stability and dielectric properties, and a wide range of predictable and controllable densities. They also provide excellent vibration damping ability, as well as thermal and acoustical insulating characteristics. They have the excellent chemical resistance characteristic of epoxy resins. They bond strongly to surfaces against which they are foamed, or they can be bonded with adhesives after foaming. Foams can be produced in large volume without overheating or burnout caused by excessive exotherm. They can be machined with standard woodworking tools.

TYPICAL PROPERTIES OF NEW EPOXY FOAMS

Type➡	Pour-In-Place: Gen Purp (Epon 828-TETA)	Pour-In-Place: High Temp (Epon 828-CL)	High Temp Powder (Epon 1031)
Density, lb/cu ft	12-14*	20-21	16
Compr Str, psi			
RT	380	1300	710
250 F	185	710	570
400 F	—	—	400
Ten Str, psi			
RT	169	620	360
250 F	—	340	175
400 F	—	—	190
Shear Str, psi			
RT	—	580	245
250 F	—	—	135
400 F	—	—	140
Shear Mod, psi			
RT	—	14,500	8800
250 F	—	—	4200
400 F	—	—	2230

*Density as low as 3.5 lb/cu ft can be obtained.

Cost of the foams is comparable to that of urethane foams of equivalent density. The method of modifying the epoxy resins is currently a subject of patent application by Boeing; we are interested in discussing possible licensing arrangements with interested firms.

Primary uses for the foams appear to be: structural reinforcement, as in aircraft hat sections and sandwich panels; encapsulation and embedments of electronic components; and lightweight cores for plastics tools and molds.

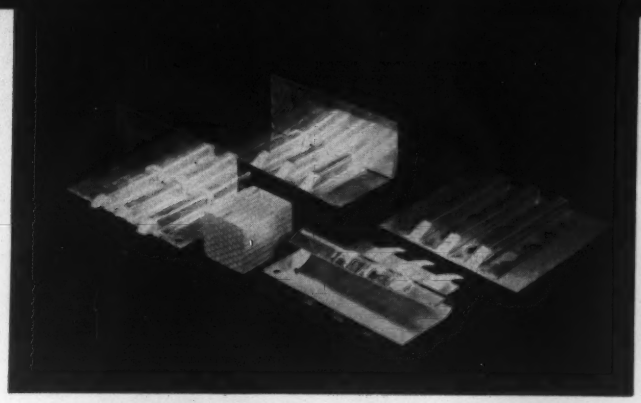
Although data are spotty as yet, the accompanying table lists available properties for two of the systems.

Pour-in-place systems

The two pour-in-place systems are based on Shell Chemical Co.'s Epon 828 epoxy resin. One is cured with TETA (triethylenetetramine) for use at temperatures up to 250 F; the other with CL Curing Agent (metaphenylenediamine) for use at slightly higher temperatures.

TETA-cured foams can be produced in densities ranging from 7 to about 13 lb per cu ft; variations in formulations can produce foams with density as low as 3.5 lb per cu ft. The foams have uniform closed cells, smaller than are common with urethane foams. Strengths of the foams are shown in the table.

The TETA-cured system has



***Powdered 500 F foam**—Complicated contours, such as metal channels and honeycombs can be easily filled by dusting dry powder in cavity and foaming and curing by heating.*

proved superior to liquid polysulfide material previously used at Boeing to pot certain electronic components. Potted units are much lighter in weight, and meet requirements for dielectric strength and mechanical shock resistance. One caution in potting is that heat must be dissipated in some way other than through the foam itself in order to prevent possible damage to the electronic components. KEY NO. 603

High temperature system

To date, maximum strength at elevated temperatures has been obtained with a one-component powdered foaming system. It consists of Shell Chemical Co.'s Epon 1031 epoxy resin premixed with diaminodiphenylsulfone. The powder needs only heat to foam, and the decomposition temperature of the cured foam is above 500 F.

The powder has exceptional storage stability, e.g., powder that has been stored for over three years at room temperature has formed foam of the same quality as fresh powder.

To foam, the powder is placed in a mold or cavity and heated to temperatures of 300 to 400 F, depending on the anticipated service temperature. At 300 F the material foams and cures in less than an hour. At 400 F (the optimum curing temperature) the material foams and cures more rapidly. If the foam is to be used at 400 F, it should be postcured for one additional hour at that temperature.

Regardless of curing temperature, the foam does not shrink. It bonds permanently to the walls of the cavity and has all the final strength properties desired.

The powdered system offers particular benefits in such applications as stiffening honeycomb structures. A liquid pour-in-place system is not usually suitable for such use because it is too viscous, and since it foams during the pour, complete filling of voids is difficult. With the dry system, the powder is only dusted into the honeycomb core to the desired level and oven-cured to foam and fill. KEY NO. 604

Postformable foam

The postformable foam is based on Epon 828 resin. When the cured foam is warmed to about 120 F it softens slightly and can be hand-shaped easily around radii and complex contours. On cooling to room temperature the foam becomes rigid and holds the new shape.

Two fabricating techniques have been found useful:

- Sawing the foam into strips, forming to the contour of an inner surface, and bonding with an adhesive; then laying up an outer surface of reinforced plastic (see photo sequence below).
- The same procedure, except that the TETA-cured pour-in-place formulation is brushed on to fill the voids between the formed and bonded strips (see photo top of this page). KEY NO. 605

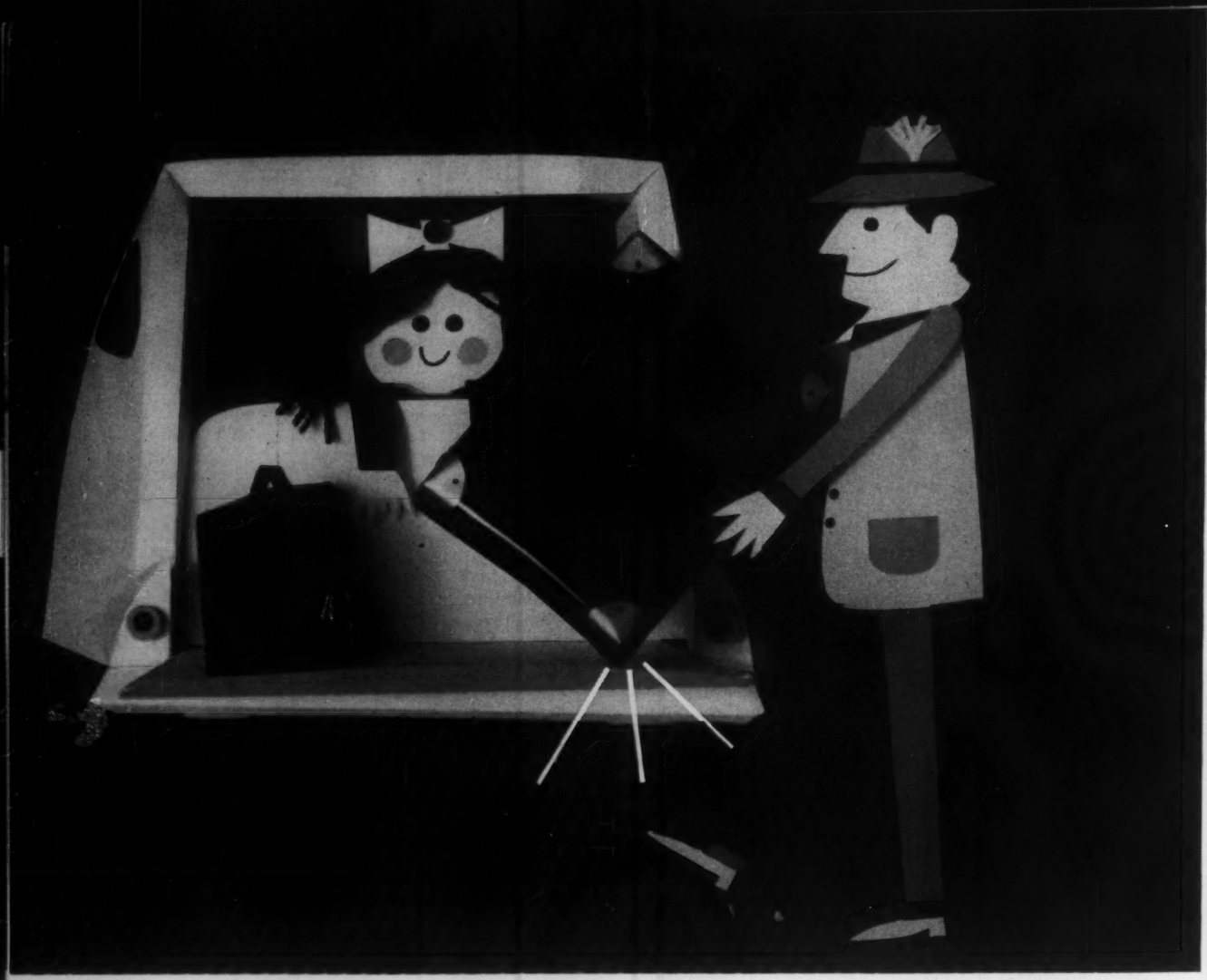
How Postformable Foam Is Used for Rib Reinforcement

by Temco Missiles & Aircraft Div.

***Foam strips are sawed** to size. They are used in constructing a reinforced plastic parachute storage compartment for the B-52H bomber.*

***Strips are postformed** to shape and bonded to inner skin of compartment with an epoxy adhesive, which is cured with a heat gun.*

***Impregnated glass cloth,** forming the first skin of the outer surface, is applied and sanded smooth prior to laying up subsequent plies.*



A TEXTURED FINISH THAT DEFIES MARRING...M&T SPRAY-ON VINYLS

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With the help of new vinyl coatings from M&T, you can get dozens of different "looks." Two basic types of coatings are available: one for a leather-like texture on smooth metal, the other to mirror the surface of mill-patterned or perforated metal. You can also apply the second type to smooth metal for a smooth mantle of protective beauty.

Automotive interiors are well suited to the multiple benefits of M&T spray-on vinyl. Parts get a richer-looking finish... one that feels warmer to the touch. And you can have it up to 15 mils thick, so the beauty lasts for the life of the car—resists scuffing, fading, chipping, staining. Because this coating is applied after metal fabrication, parts can be finished in the color ordered at decentralized plants.

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General Offices: Rahway, New Jersey
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Specifications *for this large Dynapak machine are: max energy, 431,000 ft-lb; cycle time, 105 sec; ram velocity, 250-1500 ips; stroke, 15 in.; firing pressure, 2000 psi; dwell time, 1 sec; and max die size, 22.5 in.*

Forgings Made by High Energy Process

Parts are said to have superior grain flow, high strength, good surface finish.

■ Hot forged parts are being turned out experimentally on what is claimed to be the largest vertical high energy rate metalworking machine in the world.

The machine, manufactured by General Dynamics Corp. and called Dynapak, is installed at American Brake Shoe Co.'s Research Center in Mahwah, N. J. Metallurgists there believe the machine will be ready for production orders within a few months.

Compared with conventional forging techniques, Dynapak is capable of forging parts with thinner sections, superior grain flow, greater strength, finer surface finishes, and tighter dimensional tolerances.

Uses gas pressure

The Dynapak high energy rate forming process, described in the July '60 issue of this magazine (p 95), uses gas under high pressure as the driving force.

The new machine's high ram velocity (1500 ips) creates tremendous abrupt pressure within the die cavity. These high pressures cause severe deformations, and the metal moves faster and farther than when formed by conventional methods.

In addition to forging, the machine can be used for extruding, compacting and blanking operations. Brake Shoe is primarily interested in forging and compacting applications. So far, company metallurgists have formed intricate parts out of aircraft quality 4130 steel, tough pitch copper and copper powder compacts.

Aircraft forging

A cone-shaped piston cap for a hydraulic landing gear strut was hot forged in one operation from a 2 by 2-in. cyclindrical billet of 4130 steel that had been heated to 2150 F in a salt bath.

In forging the part on the new machine, there is practically no scrap loss, according to the company. A very small amount of flash is forced into a thin ring at the outside edge of the cap where it can be easily trimmed.

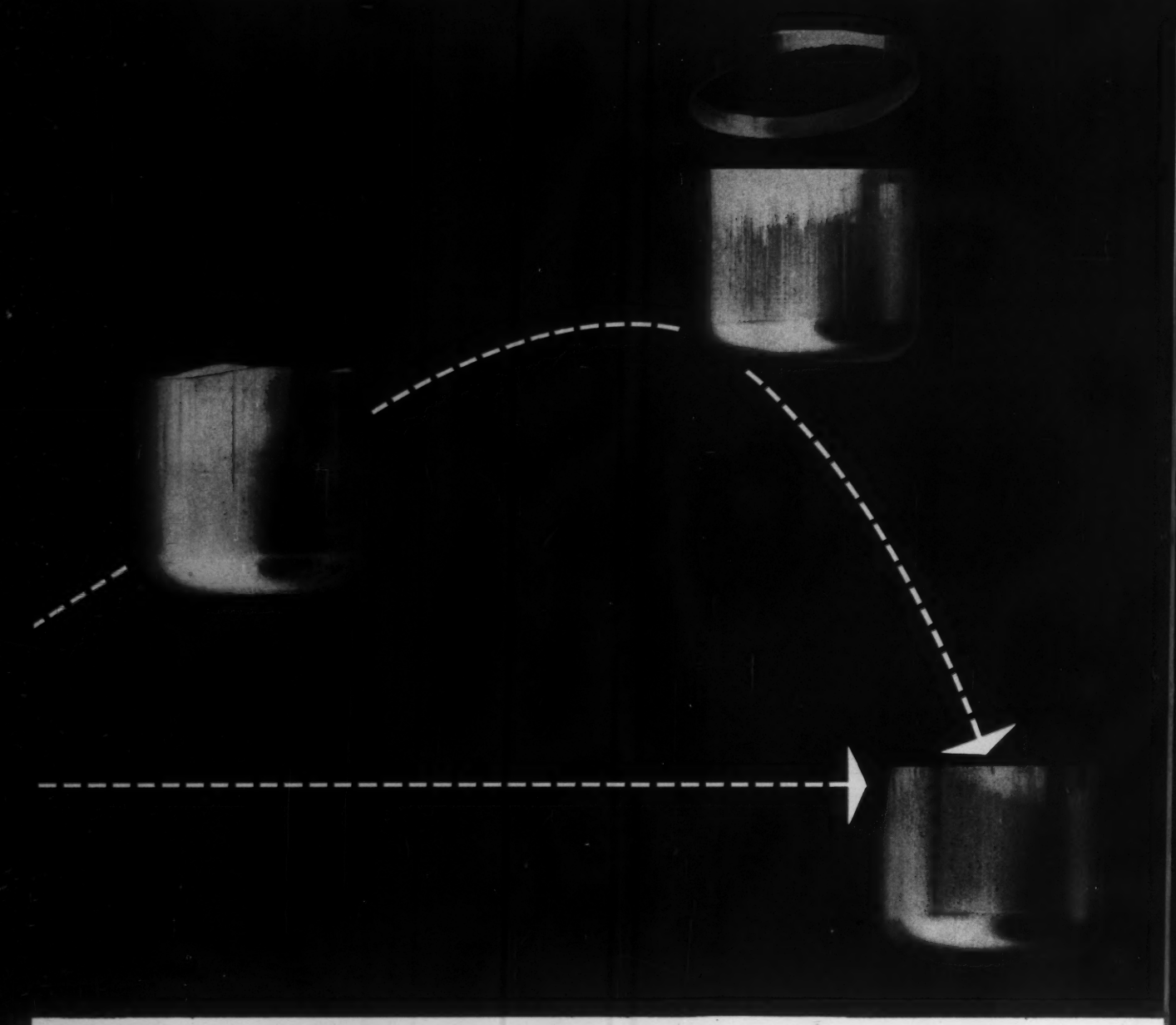
In conventional press forging operations, the part would require at least four press strokes plus finishing on a cold trim press. After trimming, the part would still need inside and outside machining before it conformed to specifications.

Not for common parts

Metallurgists at American Brake Shoe Co. believe that in all probability Dynapak will not compete where plain carbon steels are forged into relatively simple shapes. In this area, a hammer or press operation is more economical, they say. The high energy rate forming process will probably be used to its greatest advantage in making aircraft quality parts.

For more information circle No. 606

For more information, circle No. 413



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Tougher Cellular Polyethylene Made from Type III Resin

for wire and cable insulation . . .

■ What appears to be the first commercial cellular polyethylene made from a Type III (high density) polyethylene resin has been announced. Made from a resin of 0.954 specific gravity, the cellular material has strength and toughness greater than that of previously available cellular polyethylenes made from Type I (low density) resins.

The material was developed by Union Carbide Plastics Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17, and is designated DGDA-2580. It is intended primarily as extruded cellular primary insulation for wire and cable.

According to the producer, cells are dispersed uniformly throughout the material. Thus Carbide has apparently solved one of the major problems which has held up commercial development of expanded higher density polyethylene resins (see M/DE, Mar '61, p 133).

COMPARISON OF CELLULAR INSULATIONS

Property	ASTM	Cellular Type III Polyethylene[a]	Cellular Polypropylene	Solid Low-Density Polyethylene
Density, lb/cu ft	.....	40	40	57.4
Ten Str, psi	D412..	2800	3100	2200
Elong, %	D412..	300+	300+	300+
Mandrel Bend (2D), F[b]	.....	<−94	−40	<−70
Power Factor				
At 1 kc.	D150..	0.0012	0.0023	0.00018
At 50 kc.	D150..	0.0009	0.0025	0.00020
At 1 mc.	D150..	0.0006	0.0021	0.00023
Dielec Const				
At 1 kc.	D150..	1.5-1.7	1.5-1.7	2.28
At 50 kc.	D150..	1.5-1.7	1.5-1.7	2.28
At 1 mc.	D150..	1.5-1.7	1.5-1.7	2.28

[a]DGDA-2580.
[b]Lowest temperature passed.

Properties compared

A relatively high density expanded material (i.e., 30% gas by volume, or a final density of about 40 lb per cu ft), its properties are shown in the accompanying table, compared with properties of a cellular polypropylene.

(Interestingly enough, although development work on cellular polypropylene has been reported previously—see M/DE, Mar '61, p 133—no property data have been available. The data in the table were obtained by Carbide on a commercial polypropylene it expanded with a commercial blowing agent.)

High frequency cable

The improved strength, toughness and low dielectric constant should permit reduced wall thickness in telephone singles insulation, resulting in smaller, lighter and more economical multiconductor telephone cable. The material should also find uses in high frequency applications, such as video pairs, community coaxial cable and antenna lead-ins, as well as bedding for insulated members to fill out multiconductor cables.

Use of the new cellular polyethylene in telephone singles can result in considerable reduction in materials costs compared to solid polyethylene insulations. In one construction, for example, solid polyethylene would cost $1.28 per mile of single; the new material would cost about 82¢ per mile.

Normal extrusion used

Conventional extrusion equipment is recommended for use with DGDA-2580, with only a few changes in operating procedure required. The material has been extruded at speeds of greater than 2000 fpm. In addition to uniformly dispersed cells, the extrusions have smooth surfaces.

MORE WHAT'S NEW IN MATERIALS

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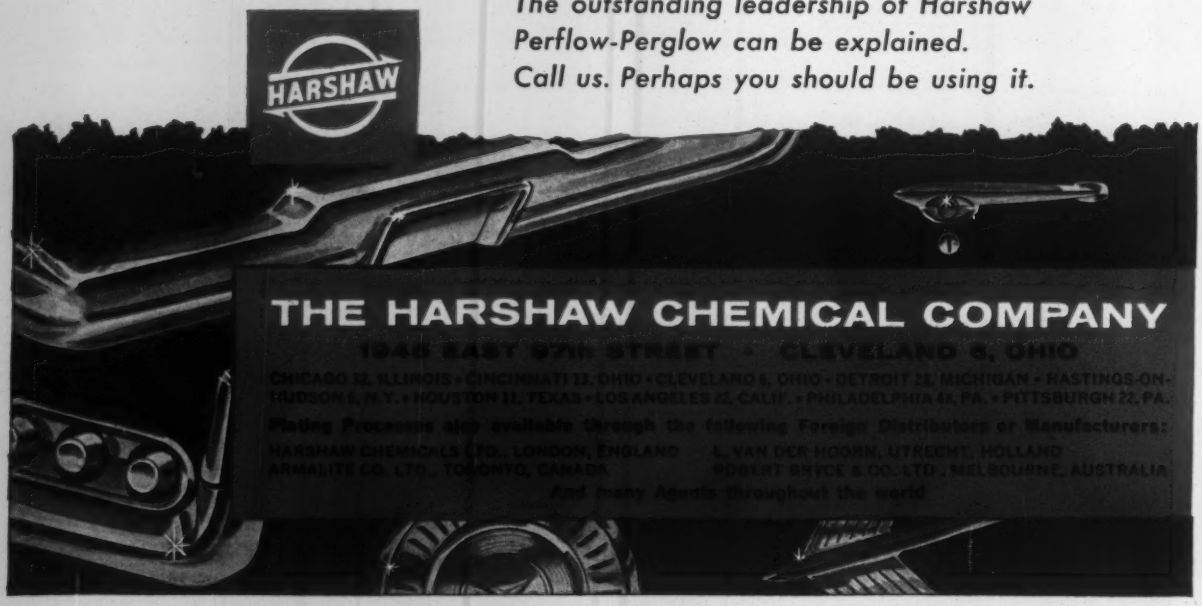
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For more information, turn to Reader Service card, circle No. 374

New Attendance Record Set at ASTM Annual Meeting in June

The best attended annual meeting in the American Society for Testing Materials' history was held in Atlantic City at the end of June.

About 3420 members attended the 64th annual meeting at which approximately 60 committees met. Previous record attendance was about 3000 with 40 to 50 committees meeting.

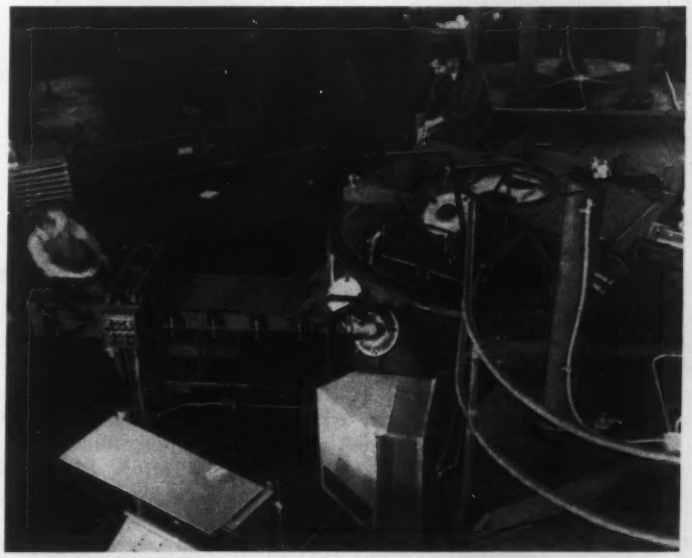
More emphasis on materials

In an address to the members, Dr. A. Allen Bates, retiring president, said that ASTM's new Div. of Materials Sciences was formed because of the growing importance of materials research. He called for effective liaison between the Division and the technical committees to decrease the lag in incorporating the results of research in industrial standards.

Otherwise, he pointed out, technological progress may outstrip the traditional structure and usefulness of ASTM.

"We have now entered the era of molecular and microstructural design in which new materials may originate not only in experiment and experience but also through mathematical calculation of macro-structural properties from known physical constants of various atomic and molecular species."

In another action that emphasized the Society's concern with materials, ASTM members voted to change the Society's name to the American Society for Testing *and* Materials. The change will not become effective, however, until the charter is changed by court action.



Largest electron beam furnace ever built has been brought on stream by the Temescal Metallurgical Corp., Berkeley, Calif. The furnace, which stands 3 stories high, has an ingot capacity of 1 million pounds per year for specialty steels and refractory metals. Ingots are produced up to 20 in. dia and 6 ft long. The furnace was developed by Temescal and has five times the capacity of the largest electron beam furnace now in operation.

Translations for Latin America

In a report issued before the meeting, ASTM's board of directors said that, as part of an effort to help Central and South American countries establish industrial standards, the government is considering supporting the translation of ASTM standards into Spanish and/or Portugese. The translation program, an immediate result of a meeting of the Pan American Standards Committee in Montevideo, in April, is the first phase of a general translation program advocated by Frank L. LaQue, past president of ASTM.

New officers elected

ASTM members elected the following officers for 1961-62: president—Miles N. Clair, Thompson & Lichtner Co., Inc.; and vice-

president—Alfred C. Webber, assistant to the laboratory director, Research and Development Div., Polychemicals Dept., E. I. du Pont de Nemours and Co., Inc. R. Wade Seniff, manager of research, Baltimore & Ohio Railroad Co., will continue as senior vice-president

Research Pushes Use of Lead, Zinc

Results of the "Expanded Research Program" sponsored by the American Zinc Institute and the Lead Industries Assn. were described at the two groups' joint annual meeting held in Chicago in May.

Goals of the program are to increase markets for the two metals by 1) improving alloys and processes, 2) finding new uses for the metals, and 3) assisting consumer industries using the metals.

Promising new uses for lead that were mentioned at the meeting include sound absorbent lead-fabric textiles, and lead zirconate-titanate spark ignition systems.

New zinc applications include: anti-corrosion anode systems for hot water tanks, improved chromium platings for zinc castings, and promising new alloys for making intricate castings.

Need for New, Improved Plastics Emphasized at SPI Conference

"The biggest problem to overcome in using plastics components in weapon systems is the reliability of the finished item."

"Much of the problem must be blamed on our inadequate knowledge of materials and their behavior," concluded Albert Lightbody of the Naval Ordnance Laboratory in a talk at the recent Society of the Plastics Industry Conference.

This year's SPI Conference, held concurrently with the 9th National Plastics Exposition in New York City, in June, featured addresses by leaders in the plastics user industries telling what their industries are doing with plastics and what they need from the plastics industry.

In discussing plastics in the automotive industry, T. H. Risk and J. R. Forrester, Jr. of the Engineering and Research Staff, Ford Motor Co., said that "a new family of working plastics is required for additional automotive components."

Risk and Forrester suggested that developing new polymers, blending or combining present polymers, developing fillers and reinforcing materials, and combining plastics with other materials during fabrication are ways to "bring about the next major increase in the use of plastics on automobiles, that is, their use as structural materials."

Other Conference events

Developments or improvements that would meet the needs of the communications, electronic packaging, building and architectural, and appliance industries were described in other sessions.

According to SPI, over 1450 plastics specialists attended the Conference.

The joint Conference and Exhibition was opened by an address by Dr. Hugh L. Dryden, deputy director, National Aeronautics and Space Administration. In outlining the aerospace potential of plastics he said that continuing requirements of the space program "will challenge the industry's technical knowledge to the limit."

Largest show yet

SPI estimates that approximately 35,470 visitors saw more than 260 exhibits at the Exposition in the New York Coliseum.

The show, the largest SPI has ever held, included displays of raw materials and equipment.

News of Societies

American Electroplaters' Society, Inc. has elected Chester G. Borlet, Grand Rapids Brass Co., national president.

The Society has granted the following awards: Scientific Achievement Award—Dr. Abner Brenner, National Bureau of Standards; Charles Henry Proctor Memorial Leadership Award—Dr. Harold J. Read, Pennsylvania State University.

American Iron and Steel Institute has awarded Charles M. White, Republic Steel Corp., the Gary Memorial Medal.

American Society for Quality Control has elected as president Dr. A. V. Feigenbaum, General Electric Co.

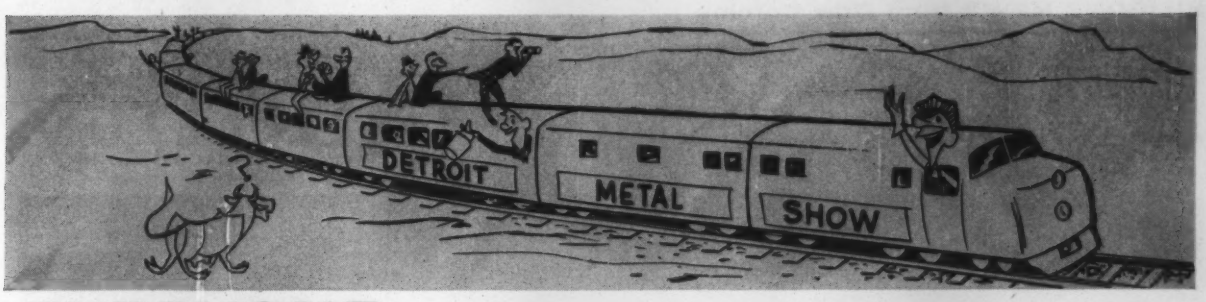
American Society for Testing Materials has elected the following directors: A. M. Bounds, Superior Tube Co.; A. G. H. Dietz, Massachusetts Institute of Technology; B. W. Gonser, Battelle Memorial Institute; W. A. Kirklin, Hercules Powder Co.; G. M. Kline, National Bureau of Standards; and J. B. Rather, Jr., Socony Mobil Oil Co.

New Standards for Alumina Ceramics

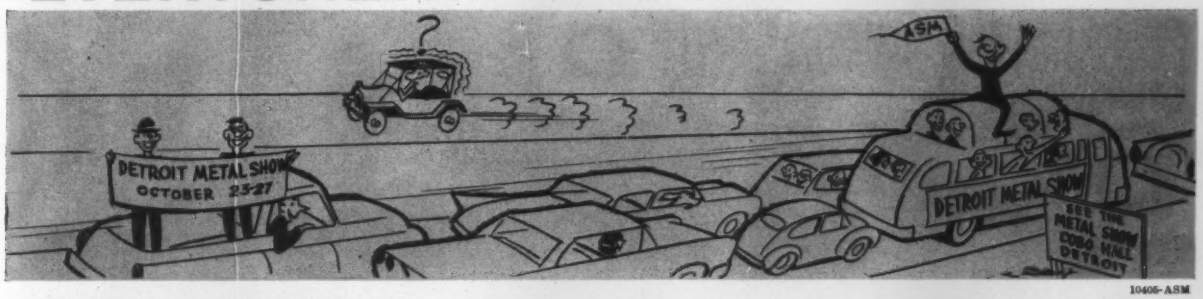
New standards have recently been compiled by the Alumina Ceramic Manufacturers Assn. to provide basic information about production, design and effective use of alumina ceramics.

The publication, *Standards of the Alumina Ceramic Manufacturers Association,* contains data on test methods, design fundamentals, resistance to nuclear radiation, and quality assurance standards.

Copies are available from: Alumina Ceramic Manufacturers Assn., 53 Park Place, New York City 7. Price: $1.00 per copy.



EVERYONE...



10405-ASM

(Well, almost everyone)...

is headed for the 1961 DETROIT METAL SHOW

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OCTOBER 23RD THROUGH 27TH • COBO HALL

Ideas . . . Ideas . . . Ideas . . . stimulating, thought-provoking ideas. How to improve production . . . how to cut costs . . . how to stay ahead of competition. SEE – hundreds of educational exhibits. HEAR – presentation of over 200 technical papers. EXAMINE – processing, inspection and control equipment. VISIT – the spectacular Materials Comparison Center. Yes, *everyone* . . . especially the IDEA man for his company . . . is headed for the 1961 Detroit Metal Show. He wants to *KNOW* more . . . DO YOU?

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USE THIS CONVENIENT ADVANCE SHOW REGISTRATION FORM! You will receive your ASM INFORMA-Badge, your credit card guest permit to the show.

Advance Registration Manager, ASM Headquarters, Metals Park, Ohio
Gentlemen: Please register myself (and the names of my associates listed below) for the forthcoming METAL SHOW at Cobo Hall in Detroit.

Name	Title	Indicate Affiliated Organization*	Registration Fee for ASM Sessions and Exposition: $2.00. (Except as noted below)

(Enclose check or money order) TOTAL

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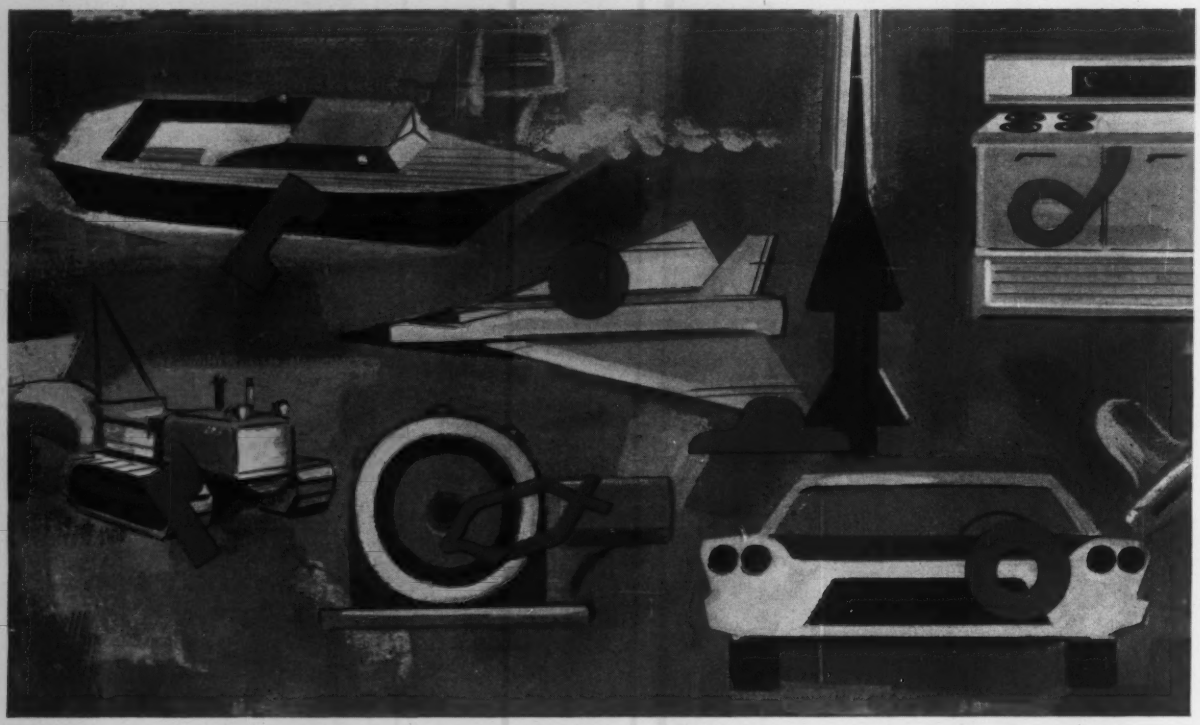
☐ AIME Members: $5.00 Registration fee includes AIME sessions, ASM sessions and Exposition;
☐ non-members: $10.00 AIME sessions, ASM sessions and Exposition.
☐ SNT Members: $5.00 Registration fee includes SNT sessions, ASM sessions and Exposition;
☐ non-members $7.00 SNT sessions, ASM sessions and Exposition.

For more information, turn to Reader Service card, circle No. 388

SILICONE NEWS from Dow Corning

Design For Quality



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Tomorrow's customers will demand quality. They'll demand trouble-free operation. They'll demand lasting durability. You'll have to meet these demands to maintain any kind of profit margin. Improvements in the design of your products will help. But more important in your *quality mix* is the selection of better, more dependable materials . . . materials like Silastic®, the Dow Corning silicone rubber.

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MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

For more information, turn to Reader Service card, circle No. 330

Coming Meetings

SEMICONDUCTOR CONFERENCE, American Institute of Mining, Metallurgical and Petroleum Engineers. Los Angeles. Aug 30-Sept 1.

AMERICAN CHEMICAL SOCIETY, national meeting. Chicago. Sept 3-8.

ENGINEERING MANAGEMENT CONFERENCE, American Society of Mechanical Engineers and American Institute of Electrical Engineers. New York City. Sept 14-15.

STANDARDS ENGINEERS SOCIETY, INC., 10th annual meeting. Chicago. Sept 18-20.

HIGH TEMPERATURE CERAMIC-ON-METAL PROCESSES CONFERENCE, American Ceramic Society. Columbus, Ohio. Sept 20-23.

STEEL FOUNDERS' SOCIETY OF AMERICA, 59th fall meeting. Hot Springs, Ark. Sept 24-26.

AMERICAN WELDING SOCIETY, fall meeting. Dallas. Sept 25-28.

PROCESS INDUSTRIES CONFERENCE, American Society of Mechanical Engineers. Houston. Oct 4-6.

CONFERENCE ON PLASTICS FOAMS, Society of Plastics Engineers, Inc., Buffalo Section. Niagara Falls, N.Y. Oct 5.

2ND INTERNATIONAL CONGRESS ON VACUUM TECHNOLOGY, American Vacuum Society Inc. Washington, D. C. Oct 16-19.

ABRASIVE GRAIN ASSN., fall meeting. New York City. Oct 23-25.

METALLURGICAL SOCIETY, AIME, fall meeting. Detroit. Oct 23-26.

43RD METAL CONGRESS AND EXPOSITION, American Society for Metals. Detroit. Oct 23-27.

AMERICAN SOCIETY OF TOOL AND MANUFACTURING ENGINEERS, semi-annual engineering conference. Toronto. Oct 26-27.

AMERICAN NUCLEAR SOCIETY, 9th Hot Laboratory and Equipment Conference. Chicago. Nov 6.

STEEL FOUNDERS' SOCIETY OF AMERICA, 16th annual technical & operating conference. Cleveland. Nov 13-15.

7TH ANNUAL CONFERENCE ON MAGNETISM AND MAGNETIC MATERIALS, American Institute of Electrical Engineers. Phoenix, Ariz. Nov 13-16.

SYMPOSIUM ON CERAMICS AND COMPOSITES, COATINGS AND SOLID BODIES, Society of Aerospace Material and Process Engineers. Dayton. Nov 14-15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, winter meeting. New York City. Nov 26-Dec 1.

28TH EXPOSITION OF CHEMICAL INDUSTRIES. New York City. Nov 27-Dec 1.

IF PHENOLICS CAN DO IT, PLENCO CAN PROVIDE IT—AND DOES—FOR THE HOOVER COMPANY

An end at last to wielding soggy mops, wringing dirty sponges, and all of the other unpleasant tasks that go with washing floors. That's what The Hoover Company of North Canton, Ohio, has done for the American housewife. Hoover's revolutionary new electric floor washer wets floors with clean water and detergent, scrubs them thoroughly, and vacuum dries them—all automatically!

In designing this unique appliance, the close juxtaposition of water and electric motor demanded that a material with high insulating properties be used in molding end plate and fan chamber. Hoover engineers found that Plenco 507 phenolic molding compound provided the insulating qualities, moisture resistance, as well as excellent dimensional stability required.

The story is the same with other leading manufacturers: an unusual product, component, or molding problem—usually answered with the help of versatile Plenco phenolics. That's true whether your specifications call for a special-purpose or general-purpose molding compound, ready-made or one that's custom-formulated. You're welcome to explore the possibilities with our technical staff at any time.

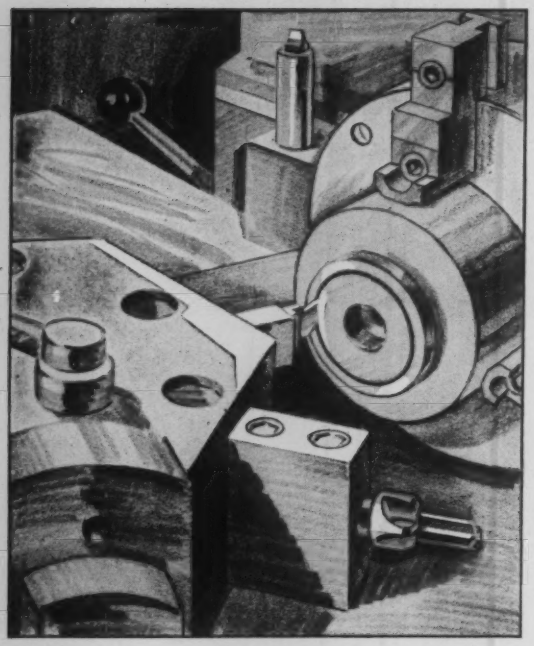
PLASTICS ENGINEERING COMPANY
Sheboygan, Wisconsin

Serving the plastics industry in the manufacture of high grade phenolic molding compounds, industrial resins and coating resins.

For more information, turn to Reader Service card, circle No. 367

THE FREE MACHINABILITY of EATON PERMANENT MOLD GRAY IRON CASTINGS

Permits Higher Feeds and Speeds, Gives Longer Tool Life



Eaton Permanent Mold Gray Iron Castings are free from inclusions and hard spots, permitting higher machining feeds and speeds, and substantially increasing tool life.

The fine dispersion of graphite and dense, non-porous, homogeneous structure make this an ideal material for many difficult machining operations where high surface finish, accurate dimensional results, and sharp corners are essential. Machining of threads is clean-cut, with good surfaces and no tearing.

Eaton Permanent Mold Iron is recommended for such critical applications as bearing retainers, connecting rods, pulleys, gear blanks, valve bodies, valve plates, hydraulic components, refrigeration and air conditioning parts. Eaton Castings are produced in sizes from 1/10 of a pound to 50 pounds.

When desirable, Eaton Permanent Mold Castings can be hardened to 40-50 Rockwell "C".

CONSIDER THESE EATON ADVANTAGES

- ★ Dense, non-porous, homogeneous structure
- ★ Freedom from inclusions
- ★ Excellent tensile strength
- ★ Ability to take a high surface finish
- ★ Freedom from leakage under pressure
- ★ Uniformity of castings
- ★ Properly annealed; no growth or distortion
- ★ Hardenable to 40-50 Rockwell "C"

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For more information, turn to Reader Service card, circle No. 339

High temperature electrical insulation

To the Editor:

Our design section is confronted with the problem of selecting high temperature electrical insulation systems for alternator stator windings used in several space power units. In brief, these systems must operate in a metal vapor atmosphere at temperatures from 0 to 500 C for 10,000 hr. We would appreciate any recommendations you could make in regard to organizations we should contact for assistance.

ALLEN T. PUDER
Technical Specialist
Aerojet-General Corp.
Azusa, Calif.

One approach to this problem—extensive use of ceramics—won first award in our recent competition for the best use of materials in product design (M/DE, May '61, p 132).

Aluminum, not aluminum-silicon

To the Editor:

Your preview of our new alloy, Precedent 71 (M/DE, June '61, p 6), erroneously identified it as a new aluminum-silicon alloy. This could prove misleading as it is not an aluminum-silicon alloy, but an aluminum alloy. . . .

N. D. O'DANIELL
William F. Jobbins, Inc.
Aurora, Ill.

A misinterpretation on our part. More information on this alloy will appear in our September issue.

Materials engineering

To the Editor:

Do you know of a text or texts which would be helpful to the instructor and students in a course in "Materials Engineering?" Our aim is the study of the basic factors determining the economical utilization of materials in engineering applications. This would include metals and nonmetals, with emphasis on the factors to be considered in selecting the materials best suited to a particular job.

HALLOCK C. CAMPBELL
Co-Director
ASM-Temple Metallurgy Course
Community College and Technical
Institute of Temple University
Philadelphia, Pa.

You might begin with these: Principles of the Properties of Materials, *Jacob Porter Frankel, McGraw-Hill Book Co., Inc., 1957;* Nature and Properties of Engineering Materials, *Zbigniew D. Jastrzebski, John Wiley & Sons, Inc., 1959; and* Elements of

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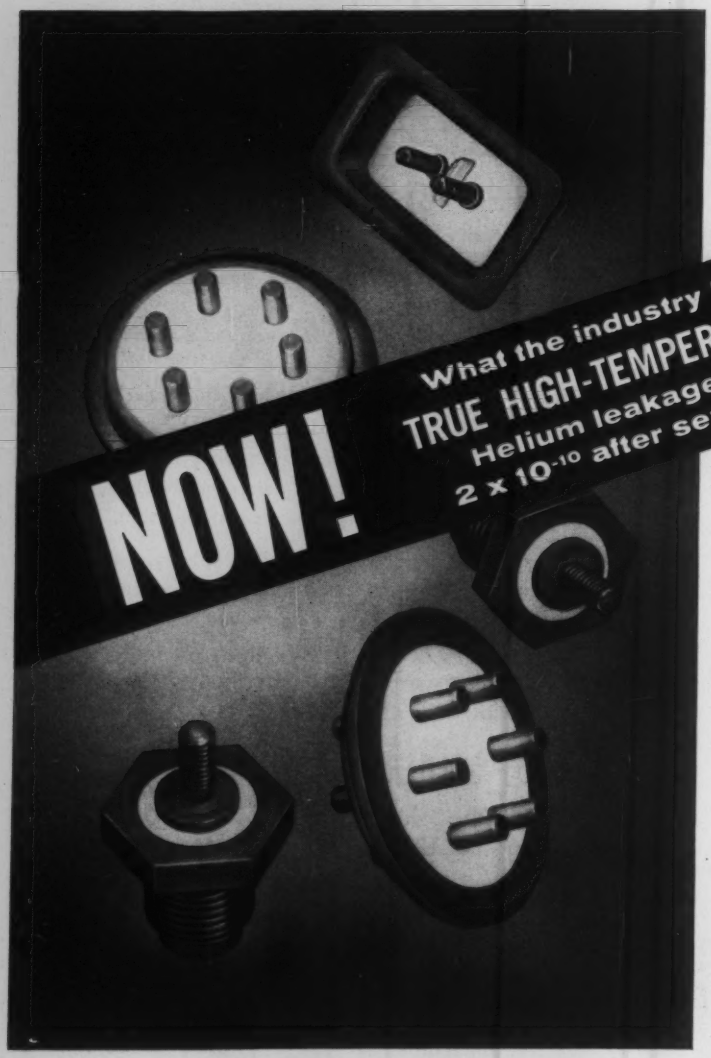
BIG NEWS in high-temperature precision-molded insulation

SUPRAMICA® 620 "BB" ceramoplastic


NOW!
What the industry has been waiting for . . .
TRUE HIGH-TEMPERATURE HERMETIC SEALS
Helium leakage rate cc/sec. less than
2 x 10-10 after severe environmental tests.

Need a precision-molded insulation material with total dimensional stability under the most adverse thermal cycling, operating to 1200°F. . . . or a material with previously unattainable combination of properties? Check these facts about new SUPRAMICA 620 "BB" ceramoplastic:

- **Maximum temperature endurance of material 1200°F. (unstressed). Heat distortion temperature of material 1100°F. (ASTM D648-264 PSI)**
- **SUPRAMICA 620 "BB" ceramoplastic can be precision molded to most intricate geometries with gauge-like tolerances.**
- **SUPRAMICA 620 "BB" ceramoplastic will not carbonize.**
- **Absolute hermetic seals achieved directly during the molding cycle. Components meet a helium leakage rate of less than 2 x 10^{-10} cc/sec., after the following environmental tests:**
  1. **Samples heat shocked a total of 20 cycles from boiling water for 30 minutes directly to ice water for 10 minutes.**
  2. **Samples heat shocked a total of 5 cycles, from 350°C. for 1 hour directly to room temperature for 10 minutes, to -70°C. for 1 hour, to room temperature for 10 minutes.**
  3. **Samples heated to 500°C. for 4 hours and directly to room temperature.**
- **Thermal expansion factor matches many metals and alloys.**
- **New SUPRAMICA 620 "BB" ceramoplastic features a dielectric strength of 270 volts/mil, 1/8" thickness per ASTM D-149.**

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For more information, turn to Reader Service card, circle No. 437

Materials Science, *Lawrence H. Van Vlack, Addison-Wesley Publishing Co., Inc., 1959. We might also suggest reprints of M/DE manuals and our special report on "The Materials Age," M/DE, Sept '60, pp 123-174.*

Urea-formaldehyde foams

To the Editor:

Your special report "What's New in Foam Plastics" (M/DE, Mar '61, p 119) was read with interest, particularly your brief comments on urea-formaldehyde foams. We were unaware that these materials were available commercially and we would appreciate any additional information you may have, especially the names of producers.

J. C. TRINASTIC
Product Manager
Product Development, Nitrogen Div.
Allied Chemical Corp.
Hopewell, Va.

As far as we know, Colton Chemical Co., Div. of Air Reduction Co., Inc., is still producing the foam. However, they have not released any additional information.

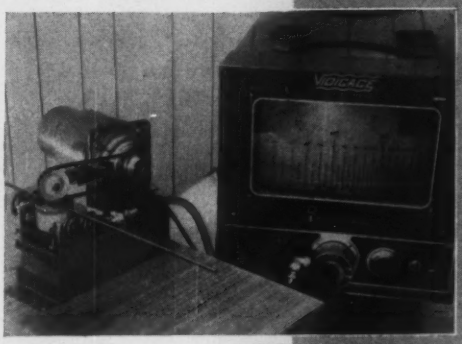
WHO'S ZEROLLING?

An article on "zerolling" in our May issue (p 10) stated that "zerolled sheet has been produced in small quantities by Universal-Cyclops Steel Co."

Further checking indicates that although this may have been true a dozen years ago when the first studies of zerolling effects began (even on this there seems to be a difference of opinion among the parties concerned), at present Universal-Cyclops has "no equipment either in our production facilities or in our laboratory that could accomplish rolling of stainless strip at temperatures referred to in your article."

It does seem clear that the stainless strip used in the research program was supplied—zerolled or not—by Universal-Cyclops many years ago and that all recent zerolling has been done in International Nickel Co.'s Research Laboratory and at Southern Research Institute. As yet no supplier has made available zerolled material, though the effect is being used in at least one defense application. The feasibility of zerolling is believed to have been first described by N. V. Krivobok and A. M. Talbot in a paper, "Effect of Temperature on the Mechanical Properties, Characteristics and Processing of the Austenitic Stainless Steels," which was published in *Proceedings of the ASTM*, Vol. 50, 1950.

ANOTHER ULTRASONIC FIRST... THICKNESS GAGING WITHOUT CONTACT



Tube scanner for VIDIGAGE® thickness gaging without contact.

Thickness gaging by means of the ultrasonic resonance technique can now be accomplished by immersion without contact. This is extremely advantageous because:

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- maintains uniform coupling of energy between transducer and work surface (this in turn makes the test more reliable!)
- avoids possible damage to work surface caused by transducer contact
- substantially increases inspection speeds

When the water column is of sufficient length the VIDIGAGE® does not respond to the water resonances. As a result the resonance thickness of the work piece can be detected by itself on the VIDIGAGE screen.

In order to take full advantage of this immersion system, the VIDIGAGE had to be modified. The modified VIDIGAGE then surpassed all expectations, especially in the gaging of small diameter, high accuracy tubing.

This development is another in the long line of BRANSON engineering break-throughs, which enables industry to solve its problems by means of ultrasonic testing. The next time you have a testing problem call BRANSON and see how fast BRANSON will find the best solution in the shortest possible time.

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GLX-W COLUMBIUM-TREATED CARBON STEEL CUTS DEAD WEIGHT 10% IN NEW

VERSATILITY...
That's the Beauty of Steel

Bringing important new economies to rail shipment of automobiles, this new tri-level auto carrier holds twelve standard cars or mixed loads of 14 standards and compacts. Capacity is increased up to 75%. A unique system of hydraulically positioning the vehicles on three levels gives a clearance of only 16 feet 8 inches, permits use in areas formerly limited to bi-level unit operation because of clearance requirements. ◆ Key feature of the Multi-Car Carrier is the movable decks on which the cars ride. Made of GLX-W columbium-treated steel, the decks are raised and lowered by built-in hydraulic lifts, actuated by a portable power unit. Here light weight was essential, in order to reduce the operating power requirements. Yet great strength was necessary, too, to support the payload. Finally, design of the decks called for eight bends in each section. So formability was also a must. ◆ GLX-W met and exceeded all these requirements. It gives 50-100% greater strength than mild carbon steel, so builder Whitehead and Kales could get the required strength with less weight. Deck operating units need less power,

Great Lakes Steel is a Division of

Multi-Car Carrier built by Whitehead and Kales for Multi-Car Corporation, Detroit, Michigan

TRI-LEVEL AUTO CARRIER

and total weight is reduced approximately 5,000 pounds or 10%. Production is more economical, too, because the ductility and formability of GLX-W permits four of the bends in the deck to be performed in one press operation. ◆ The GLX-W series of high-strength steels consists of fine-grained, semi-killed mild carbon steels, treated with varying amounts of columbium. The high strength of GLX-W permits designers to reduce the amount of steel and effect considerable cost savings when replacing mild carbon steel. GLX-W steels have a low carbon content and are readily weldable and formable. GLX-W steels are available at four minimum yield strength levels: 45,000, 50,000, 55,000 and 60,000 p.s.i. and in sheets, plates and bars. For complete technical information, write Great Lakes Steel Corporation, Product Development, Dept. MDE-9, P. O. Box 7310, Detroit 2, Michigan.

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....Engineer's Guide to Plastics
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....Designing with Metal Powder Parts
....Physical Properties & Tests
....Industrial Textiles
....Materials for Springs
....Adhesive Bonding
....Die Castings
....Impact Thermoplastics
....Material for Gaskets—Packing—Seals
....New Welding Processes
....Low Pressure Reinforced Plastics
....Low Cost Coatings for Metal Parts
....Why Metals Break; What to Do About It
....Appliances: What Materials Are Next?
....High Temperature Metals
....How Radiation Affects Materials
....Filament-Wound Reinforced Plastics
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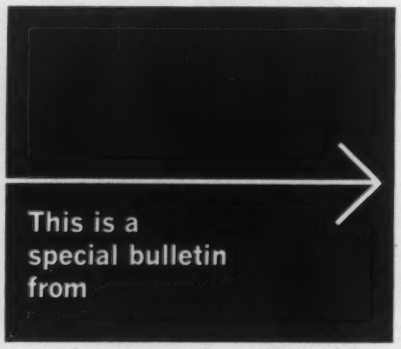

FANSTEEL C·M

A report on current projects with the refractory metals of tungsten, molybdenum, and tantalum.

The bulletin may be removed (perforated at binding). It contains engineering and technical data on specific applications of these metals as well as fabrication and production information.

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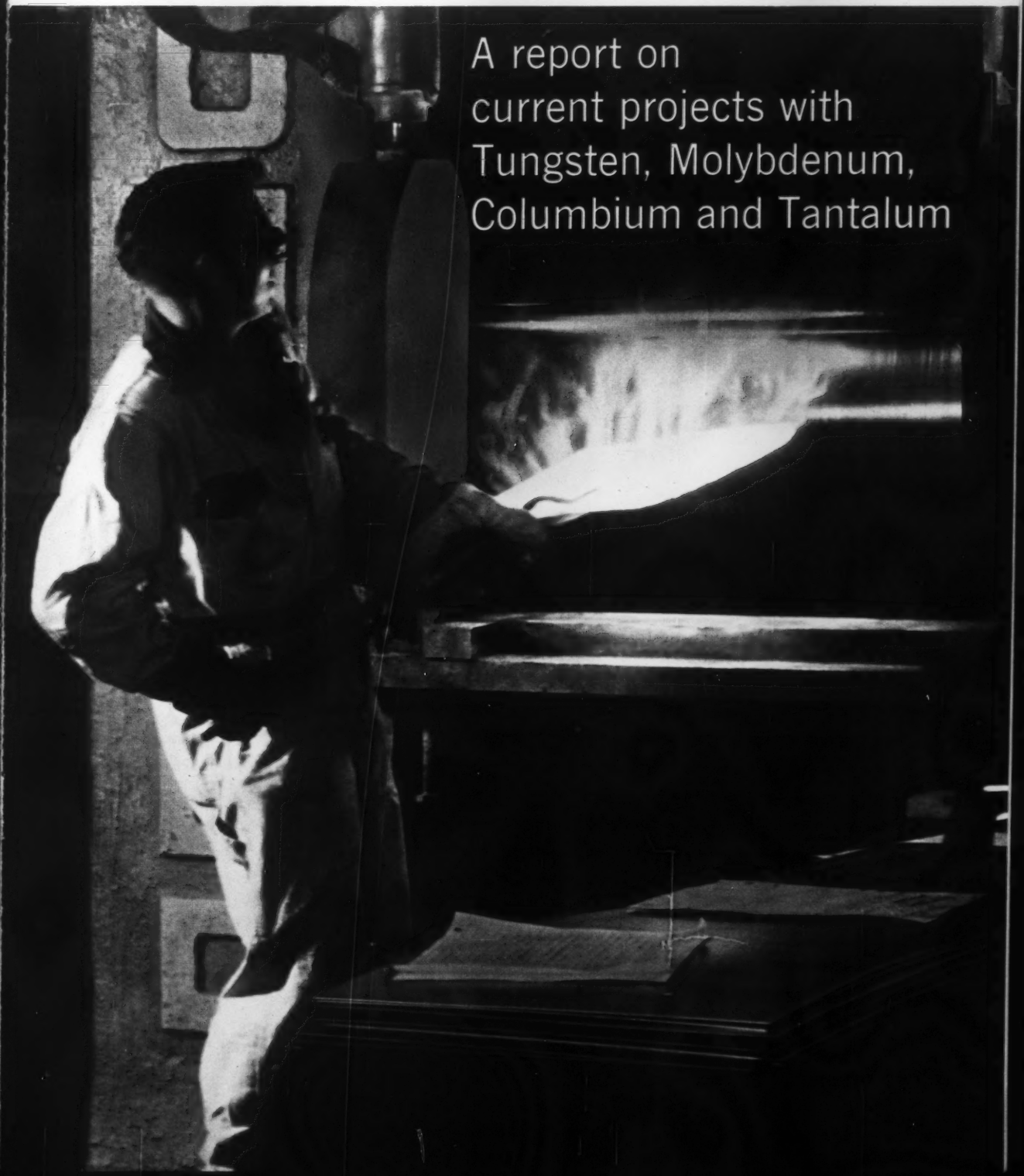
FANSTEEL

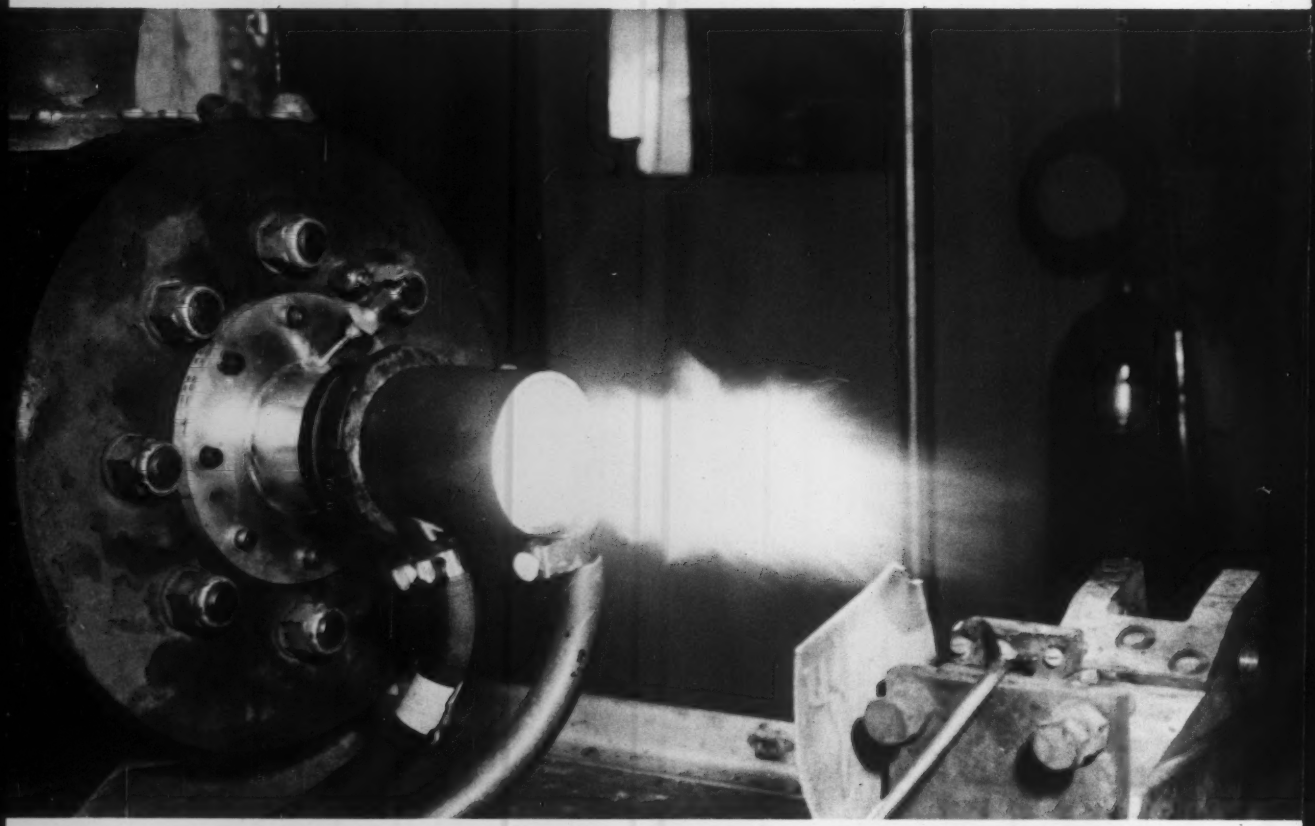
CHEMICAL AND METALLURGICAL DIVISION

Refractory Metals



A report on current projects with Tungsten, Molybdenum, Columbium and Tantalum

W, Mo, Cb, Ta
Metals for advanced concepts



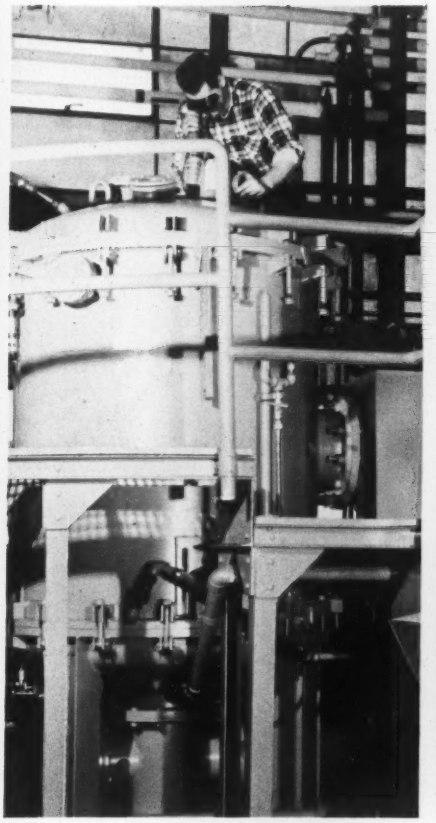
Fansteel 99 Metal (tungsten-nickel) is used as the cathode in this experimental plasma generator which reached temperatures to 30,000°F. Fansteel 99 metal proved the most durable of all metals tested for the cathode.

Has there been a period comparable to the present when the demand for new materials was more acute? Scientific developments such as solar heating, thermo electric generation, automotive turbines, nuclear power systems—all and more on the verge of commercial realization except for the right materials. In defense and space programs, where the stakes are awesome, a major materials breakthrough could mean a significant lead in weaponry or space exploration. Increasingly, interest has focused on the refractory metals of tungsten, molybdenum, columbium and tantalum to solve problems of temperature, stress, radiation, pressure and corrosion imposed by these advanced concepts.

To Fansteel (who was the first to produce tantalum on a commercial scale in 1922) falls the challenging task of supplying these space-age metals in ever greater quantities; of meeting higher demands for purity and quality; of developing new alloys and fabrication techniques. While much has yet to be discovered, more has been accomplished in the past ten years, particularly in fabrication and alloying, than in all years leading to this period.

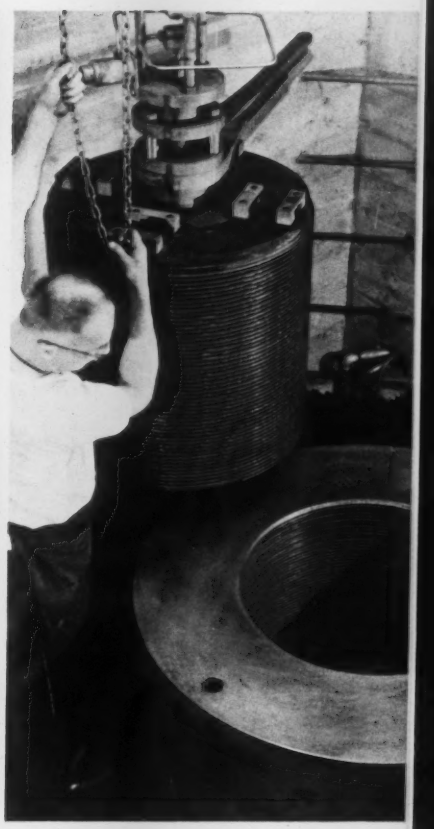
In this report (which is the first of a series) we will take you on a brief tour of the Chemical and Metallurgical Division, and by way of photos and text, bring you up-to-date on what Fansteel is doing to close the materials barrier.

FANSTEEL



Fansteel's investments in refractory metals production and fabrication facilities are among the world's largest and most complete. Specialized equipment includes vacuum induction furnaces such as this, designed by Fansteel for large-scale production of refractory metal products.

Precision foil is no secret at Fansteel, a major supplier of capacitor-grade tantalum foil for the electronics industry. Starting with metal of only the highest purity, employing the best equipment (this is one of three Sendzimir mills), skilled craftsmen produce foil of precise uniform thickness.



This is one of the largest commercially owned hydrostatic presses in the United States. 80,000 lbs. per square inch can be applied to produce a range of ingot sizes and shapes. Fansteel controls production of metal powders right from the ore.

TUNGSTEN

Shear spun tungsten cone was started from a stress relieved sheet 0.100″ thick. Spinning was done by Curtiss Wright as part of a joint development project with Fansteel. Similar work has been done with Fansteel plate up to ¼″ thick, and developments are underway to shear spin ½″ plate. Up to 75% reduction in wall thickness has been accomplished with thickness held to ±0.003″. Operations such as this can be accomplished only with tungsten metal of the highest purity and uniformity.

Welding tungsten, such as illustrated on this cylinder, is carried out at Fansteel on sheet 0.040″ thick and up. This particular cylinder, a susceptor for an induction furnace, was made from 0.090″ sheet. It has an 8″ diameter and is 13″ high. The joint was TIG* welded in a vacuum chamber. Susceptors like this are used constantly at temperatures to 2400°C.

Cylinder was made from Fansteel tungsten sheet which is available in a wide range of thicknesses and widths. Special rolling techniques insure uniformity for spinning and deep drawing
*TIG—tungsten inert gas welding.

Rocket nozzle inserts can be produced two ways: by pressing and sintering a tapered hollow preform (at left), or by forging an ingot. Fansteel supplies both ingots and preforms for this work. The preform reduces the number of forging operations required with an ingot, while some shapes can be handled more readily with the ingot.

This preform has a 6″ major O.D. with ½″ wall. It was pressed and sintered to a 92% minimum density. Fansteel has produced high-temperature furnace susceptor rings by pressing and sintering which substantially reduced waste and costs.

Tungsten ingots to 8½″ diameter by 15″ high are available from Fansteel. The ingot illustrated was hydrostatically pressed and sintered to a 92% minimum density. Controlled processes from ore to finished ingot provide the highest degree of purity and smallest variance between production runs.

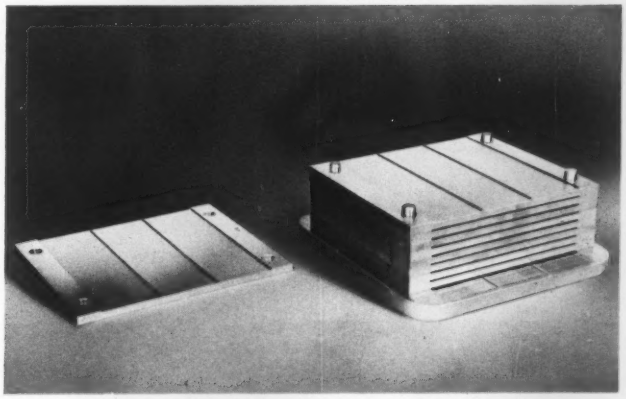
MOLYBDENUM

FANSTEEL

Vacuum furnace shield consists of a can of five concentric cylinders, the inner three formed of 0.015″ moly sheet fastened with moly rivets and two outside cylinders of nickel.

Top and bottom used the same arrangement: three inner disks of moly, outer two of nickel. The entire assembly, including the work-support pedestal (roll-formed and TIG welded of moly) was fabricated by Fansteel.

The concentric design, taking advantage of air-space insulation met shielding requirements. Use of nickel for outer cylinders, kept the assembly light and held costs low.



Sintering trays of pure moly held within extreme tolerances. That was the request Fansteel received from a company working on a nuclear project. The trays were ¼″ thick, with flatness held within 0.002″; trough parallelity with base within 0.001″; surface finish 32RMS. The troughs themselves were required to be 0.040″ deep ±0.001″.

These precision trays were fabricated from moly plate made by powder metallurgy. Milling and grinding were then carried out to required tolerances. Such precision as this with moly, tungsten, tantalum, columbium are not unusual at Fansteel.

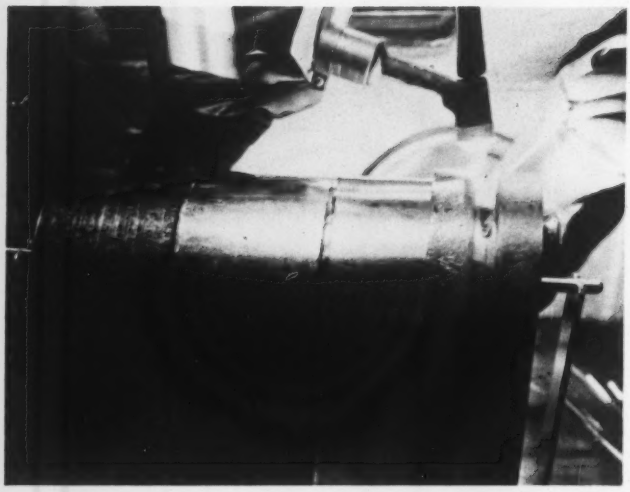
Welding, turning, milling, grinding, threading, and drilling of moly are illustrated in this photograph. Fansteel's experience with TIG welding, when worked in combination with the high purity of Fansteel moly, opens a range of fabrication possibilities including joining of moly tube with walls from 0.020″ thick and up.

The other part in this illustration is a specimen holder for a high temperature metal drawing test apparatus. This piece was turned from a moly ingot with ½% titanium to add additional high temperature strength and increased recrystallization temperature. Tolerances are held to within ±0.0005″ on hole diameter, shoulder is square with central axis within 0.0002″ full indicator reading.

COLUMBIUM

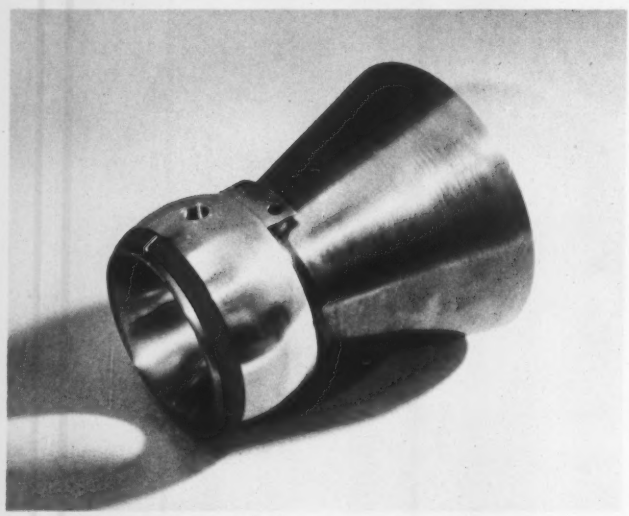
Columbium alloy wing section fabricated for hypersonic spacecraft from Fansteel 82 metal (columbium-tantalum-zirconium). Columbium alloys are attractive for structure and skin of hypersonic space vehicles for a number of reasons. In the case of Fansteel 82 metal these center on its high melting temperature (4550 °F) and its low weight (10.26g/cc). In temperature ranges from 2000 °F to 2500 °F columbium alloys exceed moly and tungsten on a strength to weight basis. In the 2000-2500 °F range, oxidation resistance of 82 metal is 100 times better than pure moly. Oxidation resistant coatings developed by Fansteel has permitted exposure of 82 metal for over 70 hours at 2300 °F.

Columbium alloys are readily fabricated. Because of low ductile brittle transition temperature of almost —200°F, columbium may be formed at room temperature. Fansteel 82 metal and other Fansteel columbium alloys are available in sheet, rod, wire, ingot, bar.



Rocket nozzle which was cold spun from a Fansteel columbium sheet for an experimental liquid-cooled nozzle design. Because of its ready fabricability and good strength to weight ratio at elevated temperatures, columbium and columbium alloys offer unlimited potential for advanced design concepts.

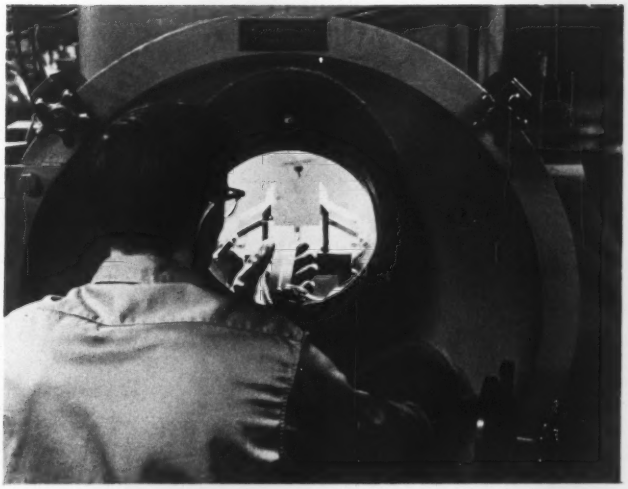
Note: this particular nozzle was made of two cones joined by welding to facilitate assembly of upper support collar.



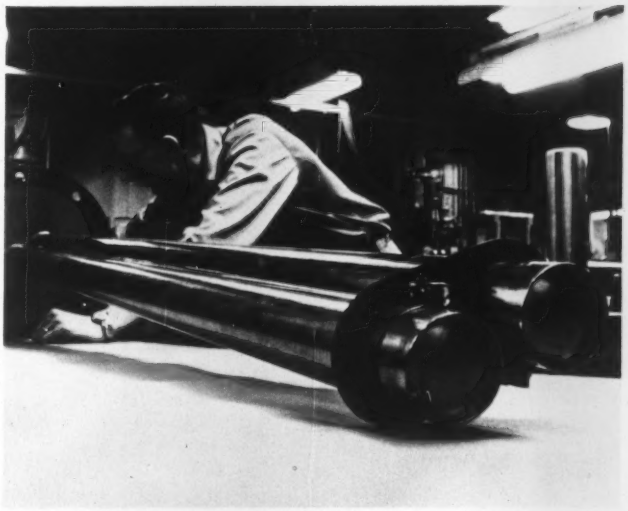
Seamless columbium tubing is furnished to order in a wide variety of wall thicknesses and diameters from Fansteel. In addition, welded tubing is available with wall thicknesses from 0.013″ and up. As a result of this metal's low neutron absorption (cross section 1.1 barns/atom) plus its high temperature strength and corrosion resistance to liquid metals, it is being studied for nuclear reactor applications.

TANTALUM

FANSTEEL



Butt welded tantalum sheet specimen is removed from the jig in a vacuum welding chamber. TIG torch is visible above the jig. Equipment such as this enables Fansteel to make difficult welds in tantalum or columbium and to handle large parts with ease. Fansteel's experience with welding of refractory metals covers more than twenty-five years. Techniques used for welding tantalum provide welds that are as strong and ductile as the basic material.



A two tube bayonet heater for chemical process applications is here pressure tested to check welding. This particular heater was fabricated from 0.015″ sheet. Tubes are 2″ O.D. x 69″ long. A range of sizes in single and three tube bayonet heaters are warehouse stocked to provide immediate delivery and low costs. Tantalum is widely used in processes involving highly corrosive chemicals. It resists all acids except hydrofluric and fuming sulfuric. Thermal conductivity is about the same as steel.

Fansteel also fabricates tantalum heat exchangers, condensers, coils, and thermowells to specifications for custom installations.

Heat shield for a rocket motor was fabricated by TIG welding a 0.015″ tantalum sheet into a 10″ loop and then forming with a bulging die. This method of fabrication eliminates considerable scrap over spin forming. Fansteel's experience with fabrication has helped many companies reduce costs through alternate methods of producing specified parts.

Refractory Metals Warehouse

Over 200 different items are held in this Fansteel warehouse. Standard mill products of tantalum, tungsten, columbium, moly and alloys as well as acid-proof tantalum chemical equipment (bayonet heaters, condensers, coils, thermowells), and special products including screws, bolts, studs, tubing, wire, foil, are available for immediate delivery. And Fansteel maintains a full staff of engineers for technical assistance on any projects.

The convenience of on-hand stocks and close factory facilities assures fast delivery whether you need a few feet of tantalum wire or a thousand pounds of moly rod. A new warehouse stock list has recently been completed which includes many new items now available for immediate delivery. Ask your Fansteel representative for the latest stock list or write direct to North Chicago, Chemical and Metallurgical Division.

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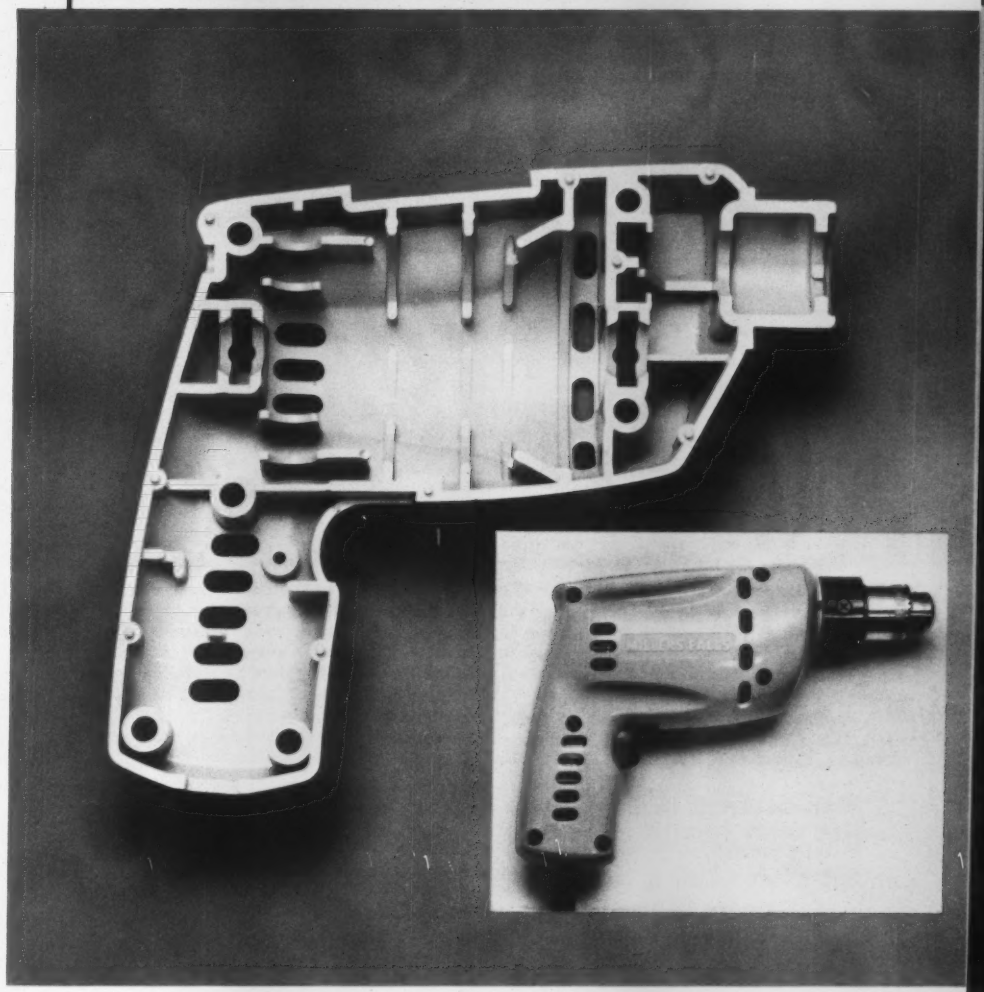

New drill housing of ZYTEL® NYLON RESINS insulates ...eliminates costly machining operations

A basic design advance in power tools, this ¼" drill is made with a nonconductive housing of Du Pont ZYTEL nylon resin. Double-insulated, it protects the user against shock hazard. Other design advantages include a weight saving: the housing of ZYTEL is 20% lighter than a comparable housing of aluminum. It is self-extinguishing. It stays comfortable to the touch in hot and cold weather and after prolonged use. It is rugged, durable and impact-resistant.

In addition, the use of ZYTEL affords substantial production advantages. The two halves of the drill housing, though complex in design, are quickly and easily molded. The excellent dimensional stability of ZYTEL assures a perfect match of each half for screw inserts, assembly and flange matings. And the housing requires no machining operations whatever.

Molded by Nylon Products Corp., affiliated with F. J. Kirk Molding Co., Clinton, Massachusetts, for Millers Falls Company, Greenfield, Mass.

On the following page you will find additional examples of practical design improvements made possible by the combination of properties that ZYTEL nylon resins offer.

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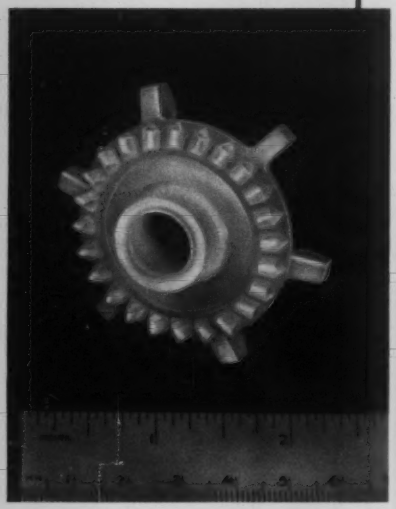
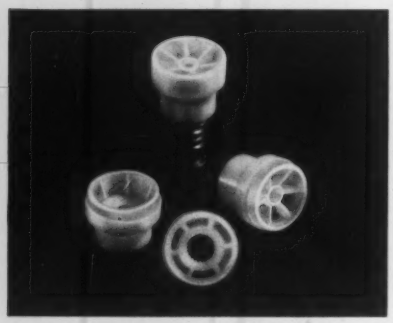
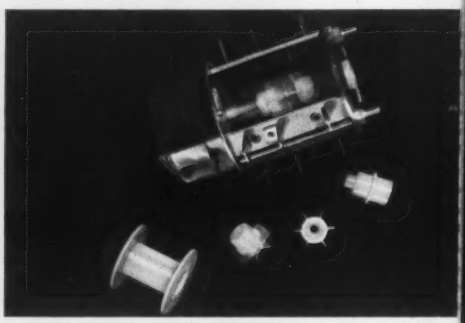
Parts of ZYTEL® NYLON RESINS perform reliably under attack by heat, impact and chemicals



This oil slinger swirls oil onto vital engine parts. It must be tough, resistant to impact, abrasion and attack by oil at high temperatures. ZYTEL provides all these resistant properties and permits economical injection molding of the part. (Molded by Sinko Mfg. & Tool, Chicago, Ill., and Danielson Mfg. Co., Danielson, Conn., for Briggs & Stratton, Milwaukee, Wis.)



These faucet-handle inserts are designed for interference-fit assembly and to act as an insulator against heat. These rugged parts of ZYTEL will withstand 116 inch-pounds torque at the stem between 20° and 160°F. They are expected to give at least 20 years of efficient service. (Molded for American Radiator & Standard Sanitary Corp., New York, New York.)



This compact switch relay uses parts molded of ZYTEL to withstand rugged treatment and yet operate quickly, smoothly and positively. Necessary in this application are good heat resistance, good electrical properties and high strength in thin sections. ZYTEL fills the bill. (Molded by Ritepoint Pen & Pencil Co., for Warco Industries, both of St. Louis, Missouri.)

An important factor in the design versatility of ZYTEL nylon resins is their ability to be molded to accurate tolerances without costly machining. Equally important is the wide variety of ZYTEL nylon resins available to meet special problems. All ZYTEL compositions have the basic properties of low friction, impact and abrasion resistance, high strength and resistance to chemicals.

Du Pont ZYTEL may help you, too, to improve the performance or the economics of a part or product. The coupon below will bring you information relating to your own problem or field of interest.

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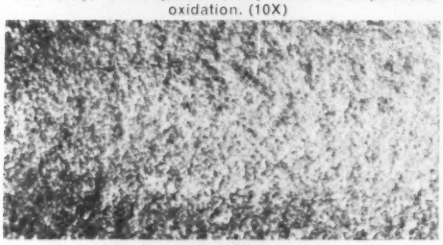
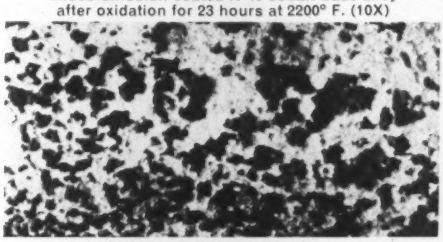
Macrophotograph of Misco "as coated" X-40 cobalt-base alloy, not subjected to any elevated temperature oxidation. (10X)



Misco diffusion coated X-40 cobalt-base alloy after oxidation for 23 hours at 2200° F. (10X)



Uncoated X-40 cobalt-base alloy after oxidation for 23 hours at only 2000° F. (10X)

One of several applications of Misco-DEW diffusion coatings provides greater surface stability to various metals and alloys in high temperature environments.

For example, the oxidation during 100 hours of exposure at 1500°F. of low-carbon steel diffusion coated by our Vapor Diffusion Department is less than one percent of the attack on the uncoated metal.

Although the nickel-base and cobalt-base high temperature alloys are generally regarded to possess inherently good surface stability, up to the temperatures at which their strength properties limit more severe environmental temperature service, Misco vapor diffusion coatings on these types of parent materials significantly—

- **Improve elevated temperature oxidation resistance up to 1800°F. for nickel-base alloys and up to 2000°F.—2200°F. for cobalt-base alloys.**
- **Decrease susceptibility to the formation of cracks in cobalt-base alloys which are occasioned by thermal shock in temperature ranges rapidly varying from ambient to 2000°F.**
- **Improve mechanical fatigue properties. For example, Inco 100 nickel-base alloy diffusion coated, utilizing the Misco-DEW vapor diffusion techniques, withstood 34,000 cycles in mechanical fatigue tests at 1500°F. This represents an improvement in excess of 30% over uncoated specimens of this alloy.**
- **Decrease corrosive attack by some media, e.g., intergranular corrosion of nickel-base alloys by sulfur-bearing gases, in elevated temperature environments.**

The formation of a suitable protective alloy case by vapor diffusion is dependent upon the coating constituents, the processing parameters, and the proper selection of the parent material.

Our staff can assist you in the solution of your protective coating problems.

Misco Precision Casting Company

DIVISION OF HOWE SOUND COMPANY

MISCO

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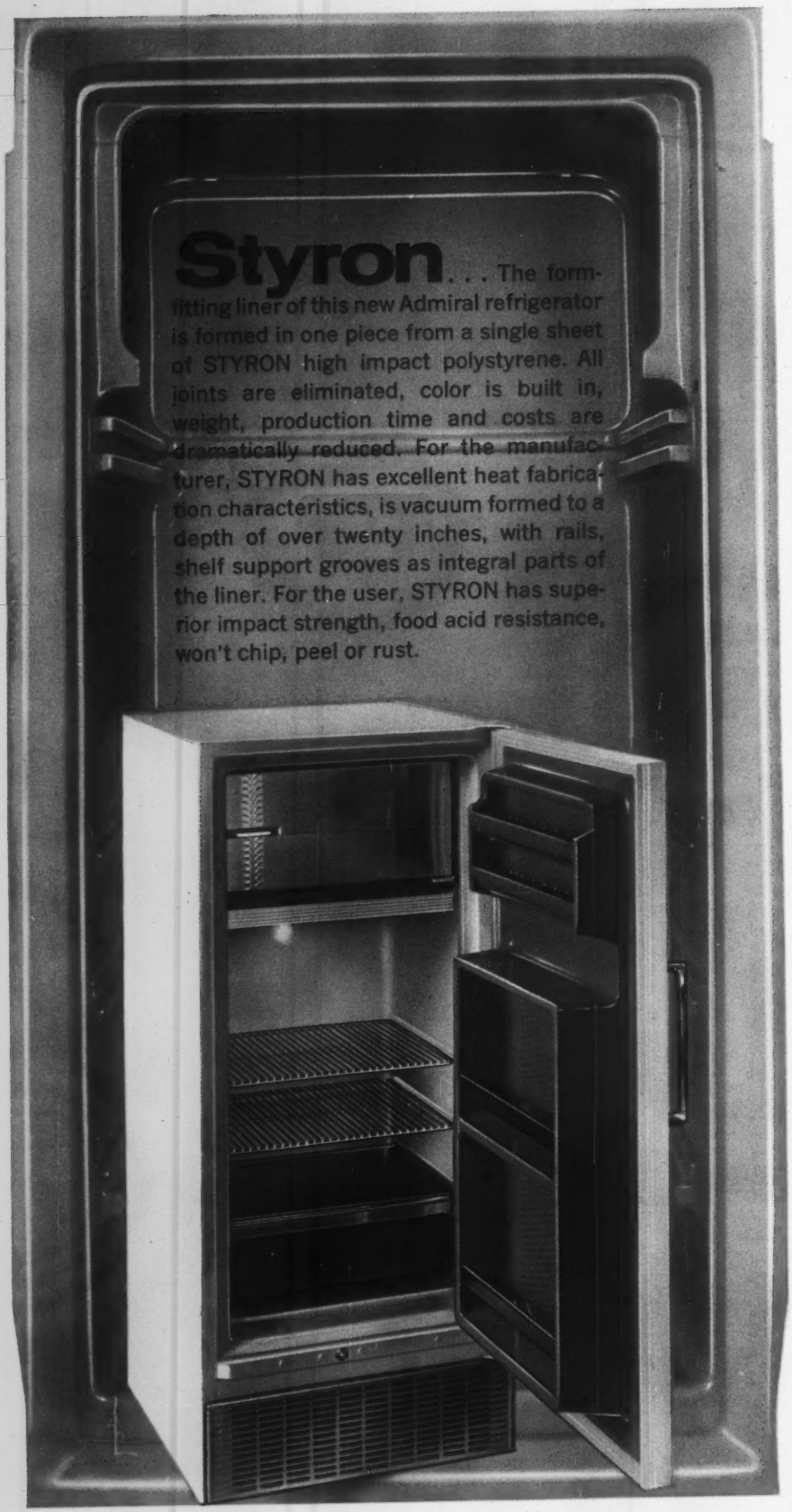

Styron . . . The form-fitting liner of this new Admiral refrigerator is formed in one piece from a single sheet of STYRON high impact polystyrene. All joints are eliminated, color is built in, weight, production time and costs are dramatically reduced. For the manufacturer, STYRON has excellent heat fabrication characteristics, is vacuum formed to a depth of over twenty inches, with rails, shelf support grooves as integral parts of the liner. For the user, STYRON has superior impact strength, food acid resistance, won't chip, peel or rust.

Styron... high impact Dow polystyrene

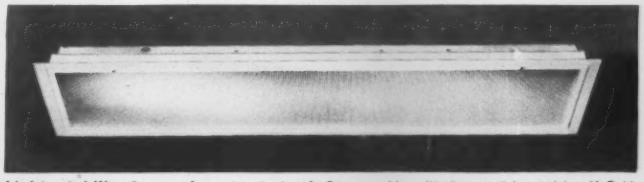
streamlines production in deep-draw, vacuum-forming operation for Admiral

The Styron® high impact polystyrene liner in Admiral Sales Corporation's new nine-cubic-foot apartment-size refrigerator cuts production time by 90% and up-grades quality and product appearance at the same time. This new concept in thermal forming offers designers and fabricators unlimited opportunities for deep-draw, one-piece components.

Using a new rotary vacuum-forming machine, and fifteen pounds of high-impact Styron 475B, Admiral deep-forms a one-piece refrigerator liner 46½" high x 23¾" wide x 20$^{12}/_{32}$" deep *in two minutes!* Contrast the half-hour total production time and the reduction in float quantities required in this operation with the five hours' total production time and twenty-two pounds of material required to fabricate the previously used liner.

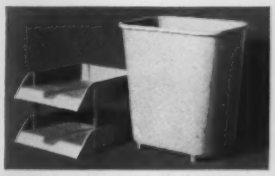
The finished design: a smooth, food acid resistant liner with built-in color that won't crack, chip, or rust . . . with no joints . . . and with more efficient insulating qualities. Formed into the liner are the crisper rail, two shelf supports, grooves, a two-position freezer drawer slide rail, and four bosses for mounting the evaporator.

The unusual size of Admiral's one-piece vacuum-forming operation opens the door to deep-drawn designs of even larger and more complex shapes. May we add our experience to yours to help solve a design problem? Drop us a line in Midland, Attention: Plastics Sales Department 1721CD8.



Light stabilized panel, extruded of Styron Verelite*, enables this K-S-H lighting fixture to provide a low brightness controlled light.

Transistor radio-phono combination by Bell Products is enclosed in case of Styron* for good impact strength and brilliant color styling.



Wastebasket by Rubbermaid uses flexible, chip-resistant, easy-to-clean Dow medium density polyethylene. Letter tray of Styron.

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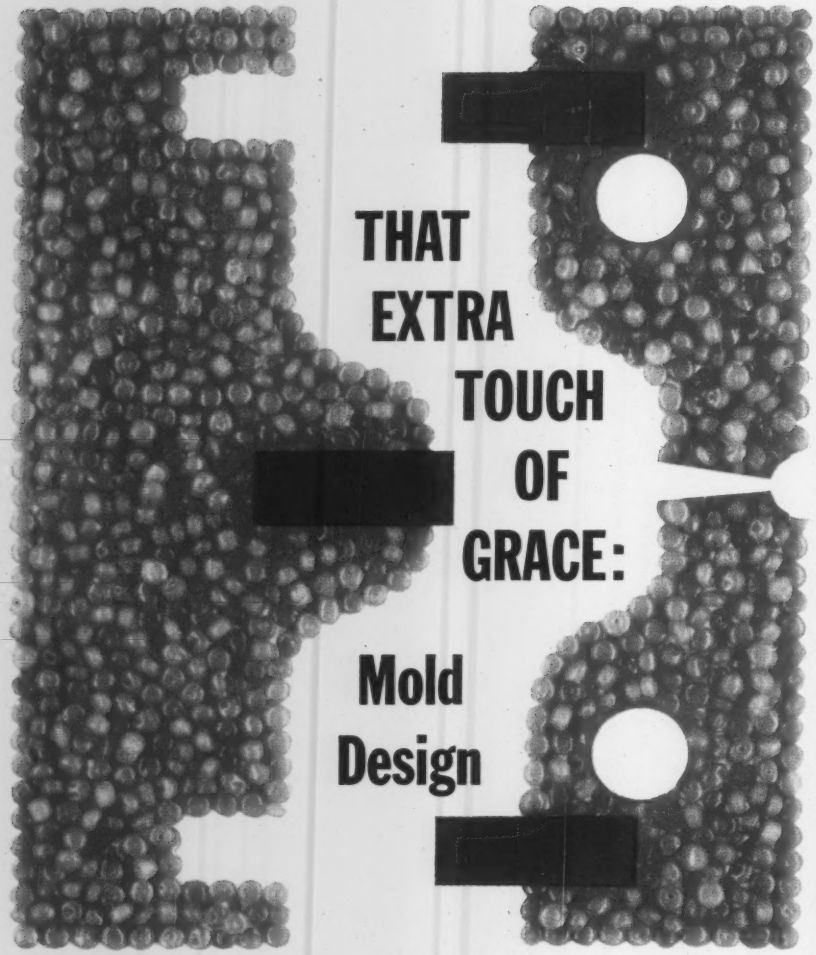

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High Strength Steels. National Steel Corp., Great Lakes Steel Corp. Div., 12 pp, illus. Chemical compositions, mechanical properties, impact strengths, heat treatments, fabrication

data, welding information, and other data on special high strength steels. **57**

Zinc-Coated Steel Sheets. National Steel Corp., Weirton Steel Co. Div., 8 pp, illus., No. 572. Advantages, characteristics, typical applications, sizes, and other information on electrolytic zinc-coated steel sheets. **58**

Wire Cloth. Newark Wire Cloth Co., 4 pp, illus. How to select, use and check various grades and types of wire cloth. **59**

Steel Tubing Weight Tables. Revere Copper & Brass Inc., 14 pp. Dimensions and weights for hot finished and cold drawn round steel tubing. **60**

Metal Stampings. Dayton Rogers Mfg. Co., 8 pp, illus., No. F-185. Information on services and facilities available for the production of small lot precision metal stampings. Includes design hints, costs and suggestions for converting various parts to stampings. **61**

Roll Formed Shapes. Roll Formed Products Co., 32 pp, illus., No. 760. Information on roll forming techniques, design, decorative finishes, precision, punching and notching, typical applications, and standard angles and channels. Includes a series of sketches showing various profiles and sizes available. **62**

Small Metal Parts. Torrington Co., Special Metal Parts Div., 24 pp, illus. Services and facilities of the company for producing small precision metal parts. Information also on contract swaging and swaging machines. **63**

Columbium in Steel. Union Carbide Metals Co., Div. of Union Carbide Corp., 4 pp. Discusses the use of ferrocolumbium in carbon and low alloy steels, high temperature alloys, stainless steel and plain chromium steels. **64**

Steel Strip. U.S. Steel Corp., American Steel & Wire Div., 48 pp, illus. Physical properties, dimensions, tempers and finishes of cold rolled stainless and carbon steel strip. **65**

Colored Stainless Steel. Washington Steel Corp., 8 pp, illus., No. B-59-3. Information on a coating process that applies uniform color finishes on stainless steel sheet and strip. Included are discussions of color range, advantages, characteristics, typical uses, and results of tests. **66**

Welded Steel Tubing. Welded Steel Tube Inst., Inc., 12 pp, illus., No. 8591. Compositions, advantages, size ranges, typical applications, fabrication information, joining methods, and other information on carbon and stainless steel welded tubing. **67**

Galvanized Sheet Steel. Wheeling Steel Corp., 44 pp, illus. Properties and uses for galvanized steel sheet and strip called Softite. **68**

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Sulfur Copper Alloy. American Metal Climax, Inc., Amco Div. Properties, uses and advantages of a new, machinable sulfur-copper alloy. **69**

Copper Alloy Forgings. Anaconda American Brass Co., Anaconda Co., 16 pp, illus., No. B-9. Mechanical and physical properties, advantages and typical applications of die pressed copper alloy forgings. **70**

Tellurium Copper. Bridgeport Brass Co. Physical, mechanical and fabrication properties, and applications of tellurium copper. **71**

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Aluminum Selector Chart. Fairmont Aluminum Co., 6 pp. Strength, thermal and electrical conductivity, density, specific gravity, melting range, weight tolerances, fabrication characteristics, available finishes, hardening properties, embossing designations, and typical uses for ten most used aluminum alloys. **76**

Aluminum Extrusions. General Extrusions, Inc., 16 pp, illus. Information on how to specify aluminum extrusion alloys, including data on mechanical properties, standard mill finishes, special finishes, extrusion tolerances and typical products. **77**

Wire Cost Calculator. Hoskins Mfg. Co. Pocket-size calculator provides megohms-per-lb and cost-per-megohm of enameled nickel-chromium and iron-chromium-aluminum precision resistor wire. **78**

Indium Alloys. Indium Corp. of America, 93 pp, graphs. Constitution diagrams of various indium alloy systems. **79**

Beryllium Copper Springs. Instrument Specialties Co., Inc., 20 pp, illus., No. 11. Characteristics, advantages, tolerances, and uses of beryllium copper compression springs, flat springs, strip springs, finger contact strips, contact rings, and other parts. **80**

History of Metals. Kaiser Aluminum & Chemical Corp., 32 pp, illus., Jan-Feb '61. Interesting booklet describes major developments in the history of metals, especially aluminum. Includes a chronology of metals, covering discovery, application, and supporting arts, from 5300 B.C. to the present. **81**

Die Castings. Mt. Vernon Die Casting Corp., 16 pp, illus. Information on facilities and services available for the production of aluminum and zinc high pressure die castings. **82**

Metal Powder Part Design. New Jersey Zinc Co., Market Development Div., 24 pp, illus. General information on the powder metal process and its current uses. Covered are compositions and properties of nonferrous alloys, commercial tolerances, practical design suggestions and elements affecting cost. Included are 27 case histories showing uses of brass and nickel silver metal powder parts. **83**

Die Castings. Newton-New Haven Co., 6 pp, illus. Services and facilities available for the production of aluminum and zinc die castings. **84**

Specialty Tubing. Olin Mathieson Chemical Corp., Metals Div., 8 pp, illus. Processing information, technical data and typical applications of special tubing designed into a single, homogeneous sheet of metal. **85**

Aluminum and Its Alloys. Joseph T. Ryerson & Son, Inc., 20 pp, illus., No. 30-1. Specifications, analyses, mechanical properties, tolerances, machinability ratings, finishes, corrosion resistance, and relative costs of aluminum foil, sheet, plate, tubing, pipe, rod and bar. **86**

Zinc Die Castings. St. Joseph Lead Co., 22 pp, illus. Discusses zinc die casting alloys and commercial finishes for zinc die castings. **87**

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Precision Die Castings. Twin City Die Castings Co., 14 pp, illus. Facilities for making precision die castings from zinc, aluminum and lead-base alloys. **89**

Plastics & Rubber

• *Parts* • *Forms*

Acrylic Rods, Shapes. Ace Plastics Co., Industrial Div., 2 pp, illus. Sizes, uses and dimensions for acrylic rods, tubes and shapes. **90**

Extruded Nylon. Allied Chemical Corp., Plastics Div., 4 pp, illus. Contains actual samples of extruded nylon tubing, tape, rod and shapes. Gives physical properties, dimensions and uses. **91**

Tube and Pipe Insulation. American-Marietta Co., Pressite Div., 4 pp, illus., No. PE 5840. General information, physical and chemical properties, advantages, and uses of expanded neoprene insulation for tube and pipe. **92**

Laminated Plastics. Continental-Diamond Fibre Corp., Newark, Del., 20 pp, illus., No. D-61. General descriptions, advantages, characteristics, properties, sizes, specifications, and other information on laminated plastics sheet, rod and tube. Includes information on metal-clad grades. Write on company letter directly to Continental-Diamond Fibre Corp.

Hydraulic Packings. Crane Packing Co., 16 pp, illus., No. P-333. Specifi-

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cations and design data for fabric reinforced and homogeneous rubber hydraulic packings, v-rings, u-cup packings and piston cup packings. **93**

Floating Structures. Dow Chemical Co., Plastics Sales Dept., 24 pp, illus., No. 32-B (NN). Advantages, limitations, sizes, properties, design information, and typical applications of floating structures made with polystyrene foams. **94**

TFE-Coated Fabrics. E. I. du Pont de Nemours & Co., Inc., Fabrics & Finishes Dept., Fabrics Div., 4 pp. Mechanical, chemical and thermal properties, formability and uses of TFE-fluorocarbon resin-coated glass fabrics and laminates. **95**

Acetal Resin. E. I. du Pont de Nemours & Co., Polychemicals Dept., 24 pp, illus., No. A-18404. Properties, design considerations, forming techniques, and typical applications of acetal resin. Discusses strength and stiffness, resilience, impact and fatigue resistance, gear properties, friction and bearing properties, abrasion, chemical and heat resistance, dimensional stability, and fabrication and finishing. **96**

Molded, Extruded Rubber Parts. Garlock, Inc., 6 pp, illus., No. AD-167. Describes various types of molded and extruded rubber parts for use on automobiles, aircraft, machinery and appliances. **97**

High Density Polyethylene. Goodrich Gulf Chemicals, Inc., 12 pp, illus., No. 1. Physical, electrical, and chemical properties; specific advantages; and other information on high density polyethylene. **98**

High Density Polyethylene. W. R. Grace & Co., Polymer Chemicals Div., 20 pp, illus., No. ET-4607. Information on 101 commerically successful applications of high density polyethylene. Included is a chart giving physical, electrical, chemical and other properties; and design considerations. **99**

Thermoplastic Coil Bobbins. Gries Reproducer Corp., 2 pp, illus., No. 3003. Sizes, advantages and characteristics of coil bobbins precision molded from nylon, acetal, CFE and other plastics. Included is a chart on electrical properties of nylon. **100**

Polypropylene. Hercules Powder Co. Inc., 20 pp, illus., No. 500-302C. Mechanical, physical and electrical properties; chemical resistance; aging characteristics; and typical uses of polypropylene. Included is information on injection molding, extrusion, blow molding, and vacuum forming. **101**

Phenolic, DAP Plastics. Durez Plastics Div., Hooker Chemical Corp., 16 pp, illus. Properties of 33 phenolic and 3 diallyl phthalate molding compounds. **102**

Butyl Rubber. Enjay Chemical Co., Div. of Humble Oil & Refining Co., 12 pp, illus., No. 2d/En. Weather, sunlight, chemical, solvent and heat resistance, electrical properties and uses of butyl rubber. **103**

Plastics Properties. A. L. Hyde Co. Chart gives mechanical and electrical properties, and test methods, for polycarbonate, acetal, nylon, and acrylic plastics. **104**

Vinyl On Metal. Monsanto Chemical Co., Plastics Div., 20 pp, illus. Advantages, characteristics, and uses of vinyl-coated metal parts. **105**

Plastics Extrusions. National Vulcanized Fibre Co., 4 pp, illus. Facilities for making extruded shapes and fabricated parts from nylon, acetal and chlorinated polyether resins. Advantages, uses and limitations of the three plastics materials. **106**

Fabricated Plastics Parts. Polymer Corp., Polymer Corp. of Pa. Div., 8 pp, illus., No. BR-110. Information on screw machining, blanking, turning, milling, drilling, and forming of nylon, TFE, polystyrene, polycarbonate, and other plastics. Included is a chart of standard tolerances for fabricated parts. **107**

Machining TFE. Raybestos-Manhattan, Inc., Plastic Products Div., 12 pp, illus., No. 0701. Stress relieving; tools and coolants; speeds and rates of feed; rakes, angles, and clearances; turning, boring, drilling, tapping, reaming, counter boring, and grinding; tolerances; and other information on machining TFE plastics. **108**

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Polystyrene. Shell Oil Co., Shell Chemical Co. Div., 2 pp, No. SC-60-100. Information on facilities and services available for the production of polystyrene compounds for molding, extruding, and vacuum forming. **111**

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Silicones. Union Carbide Corp., Silicones Div., 16 pp, illus., No. SF-1000C. General information on what silicones are and where they are used. Specific discussions on physical, mechanical and electrical properties; and typical uses in electrical and electronic equipment; aircraft and missiles; appliance, automotive and metal working production; textile, paper, glass, and plastics fabrications; rubber products; etc. **114**

Flexible Plastics Tubing. U. S. Stoneware Co., Plastics and Synthetics Div., No. T-97. Sizes, properties and uses for a flexible, clear plastics tubing called Tygon. **115**

Other Nonmetallics • Parts • Forms

Colloidal Graphite. Acheson Industries, Inc., Acheson Colloids Co. Div., 4 pp, illus., Vol. 5, No. 3. Case histories illustrate the advantages of colloidal graphite for use as high temperature lubrication, die cavity insulation, and mold release. **116**

Properties of Ceramics. American Lava Corp., Steatite Div., illus., No. 611. Chart lists physical, mechanical, and electrical properties of steatite, forsterite, zircon, cordierite, alumina, and other ceramic materials. **117**

Boron Nitride. Carborundum Co., Refractories Div., 4 pp, illus. General description; composition; advantages; physical, electrical and mechanical properties; and prices of boron nitride ceramics. **118**

Castable Ceramic Fiber. Carborundum Co., Research & Development Div., 3 pp. Properties, casting procedures, prices, and suggested uses of a castable ceramic fiber. **119**

Beryllia Ceramics. Coors Porcelain Co., 2 pp, illus. Property chart lists mechanical, physical, electrical and other properties of two beryllia ceramic compositions. **120**

Technical Ceramics. Du-Co Ceramics Co., 8 pp, illus., Nos. 59-10, 60-5, 60-6. Physical, mechanical, and electrical properties of steatite, forsterite, alumina, mullite, zirconia, and other technical ceramics. Includes technical data and specifications on insulation tubing for thermocouple wire. **121**

Graphite. Graphite Specialties Corp., 4 pp, No. GS-101-1. Chemical and physical properties of an impervious graphite for high temperature parts. **122**

Dielectric Coolant. Minnesota Mining & Mfg. Co., Chemical Div., 6 pp, illus., No. Y-ILL (8015) J-O. Heat transfer, electrical and surface properties; high temperature and chemical stability; radiation resistance; typical uses; and other information on a line of dielectric coolants. **123**

Paper Products. Mosinee Paper Mills Co., 3 pp, illus. Outlines uses and advantages of a flame resistant paper and average physical properties of flat and creped neutral papers. **124**

Insulating Materials. Mycalex Corp. of America, 4 pp. Chart compares electrical, thermal, and physical properties of commonly used plastic and ceramic insulating materials with various formulations of ceramoplastics and glass-bonded mica. Also included is a list of temperature limits

for 88 different materials and a table of thermal expansion coefficients for 57 widely used insert metals and insulating materials. **125**

Carbon and Graphite. Stackpole Carbon Co., Carbon Products Div., 54 pp, illus., No. 40 C. Properties, and mechanical, chemical, electrical and refractory applications of carbon and graphite products. **126**

Carbon-Graphite Materials. Union Carbide Corp., National Carbon Co. Div., 8 pp, illus., No. S-5425. Descriptions of 18 grades of carbon, graphite, and carbon-graphite materials for bearings, bushings, and seals. Includes advantages, characteristics, and properties for each grade. **127**

Treated Felts. Western Felt Works, Treated Felts Section. Properties and uses of felts treated with TFE, polyester and polyethylene resins. Contains samples. **128**

Carbon-Graphite Parts. Wickes Corp., U. S. Graphite Co. Div., 6 pp, illus., Winter '61. Information on development, design, production, and applications of carbon-graphite parts, powder metallurgy parts, graphite products, and electrical motor and generator brushes and contacts. **129**

Finishes • *Cleaning & Finishing*

Chromate Conversion Coatings. Allied Research Products, Inc., 28 pp, illus. Discusses chromate conversion coatings for zinc, cadmium, copper, brass, bronze, aluminum, magnesium and silver. **130**

Phosphate Conversion Coating. Amchem Products, Inc., 4 pp, illus., No. 1380A. General information on advantages, method of application and uses of a phosphate conversion coating for iron and steel. Included is a phosphate selection chart. **131**

Urethane Coatings for Wood. B. B. Chemical Co., United Indus. Sls. Div. Bostik Dept., 4 pp, No. 3-60. Materials and basic techniques, mixing and pot life, surface condition, priming, methods of application, and other information on two clear urethane coatings for wood. **132**

Ultrasonic Cleaning. Branson Instruments, Inc., 14 pp, No. S-700. Physical properties, suggested applications, working temperatures, procedures, and other information on several chemicals used in ultrasonic cleaning. **133**

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Nickel Alloy Coatings. Kanigen Div., General American Transportation Corp., 12 pp, illus., No. 258. Frictional properties, abrasion, corrosion and salt spray resistance, uses, ductility and thermal conductivity of Kanigen chemically deposited nickel alloy coatings. **135**

Bright Nickel Plating. Harshaw Chemical Co., Scientific Div., 4 pp, illus. Advantages of Nubright bright nickel plating process. **136**

Porcelain Enamels for Aluminum. Lead Industries Asso., 6 pp, illus., No. 5. Information on what porcelain enamels are, where they are used, and properties and advantages of porcelain enameled aluminum. **137**

Coatings for Mirrors. Libby-Owens-Ford Glass Co., Liberty Mirror Div., 32 pp. Reflectivity, adherence, hardness, durability, water resistance, effect of temperature and other information on a line of coatings for mirrors. **138**

Silicone Coating. Midland Industrial Finishes Co., 4 pp, illus. Properties, application data, corrosion resistance and uses of a silicone coating. **139**

Ultrasonic Cleaning. Oakite Products, Inc., 4 pp, illus., No. 16A. Information on how the ultrasonic cleaning process works, parts most suitable, efficient use of equipment, and available cleaning solutions. **140**

Conversion Coatings. Parker Rust Proof Co., 4 pp, illus., Sept-Oct, '60. Series of typical applications illustrate the advantages of a corrosion resistant conversion coating for aluminum. **141**

Coated Fabrics. Reeves Brothers, Inc., Vulcan Div., 12 pp. Physical properties, performance characteristics, and typical applications of more than 200 different styles of rubber-coated fabrics. **142**

Industrial Gold Plating. Sel-Rex Corp., 8 pp, illus. Bath composition, equipment and operating conditions, and comparative metallurgical characteristics of an industrial gold plating used on various base metals. **143**

Joining & Fastening

Welding Rods. American Chain & Cable Co., Inc., Page Steel & Wire Div., 8 pp, illus., No. DH-1277-B. Composition, physical properties and welding procedures for welding rods used for fabricating ferrous metals. **144**

Lock, Weld and Clinch Nuts. Grip Nut Co., 12 pp, illus. Specifications and applications for Gripco fasteners. **145**

Silver Brazing Course. Handy & Harman, 8 pp, illus. Information on a new self-study course in silver alloy brazing. Covers scope of course, textbooks, and materials. **146**

Silver Brazing Alloy Preforms. Lucas-Milhaupt Engineering Co., 20 pp, illus. Advantages, characteristics, uses, specifications, design information, typical applications, and other data on silver brazing alloy preforms. **147**

Adhesives, Coatings, Sealers. Minnesota Mining & Mfg. Co., Adhesives, Coatings & Sealers Div., 12 pp, No. A-ZBD-102-JR. Series of fold-out tables give uses, characteristics, and general properties of over 170 different adhesives, coatings and sealers. **148**

Vacuum Furnaces. New York Air Brake Co., Kinney Vacuum Div., 28 pp, illus. Describes high vacuum furnaces for heat treating, annealing, brazing, melting, alloying and steam degassing of metals. **149**

Pressure-Sensitive Tapes. Permacel Inc., 12 pp, illus. Characteristics, advantages, uses, and other information on a line of pressure-sensitive and heat sealing cloth tapes. **150**

Fabricating Titanium. Republic Steel Corp., 24 pp, illus., No. 3. Data on the latest approved methods of fabricating and welding titanium and titanium alloys. Covers forming, cutting, blanking, tooling, lubricants; and fusion, resistance, flash butt, and pressure welding; and brazing. **151**

Lock Screw Fasteners. Russell, Burdsall & Ward Bolt & Nut Co., 3 pp, illus. Advantages and dimensions of spin-lock screws. **152**

Resin for Neoprene Adhesives. Schenectady Varnish Co., Inc., Resins Div., 4 pp, illus., No. SR-351. Properties, solubility, handling characteristics, compounding information, heat resistance, typical applications, and other information on a new phenolic resin for industrial and general purpose neoprene adhesives. **153**

Set Screws. Set Screw & Mfg. Co., 28 pp, illus., No. 21. Information on self-tapping and stainless steel set screws. **154**

Fasteners. Simmons Fastener Corp., 42 pp, illus., No. 1257. Sizes, installation data, characteristics and uses of plastics and metal fasteners. **155**

Epoxy Pellet Adhesives. Joseph Waldman & Sons Epoxy Products Div., 4 pp, No. 6. Bond strength; thermal, electrical, and chemical characteristics; selection information; and typical applications of epoxy pellet adhesives. **156**

Methods & Equipment • *Testing*

Fatigue Testing Machine. American Machine & Metals, Inc., Riehle Testing Machines Div., 12 pp, illus., No. RF-2-61. Advantages, characteritics, specifications, procedures, uses, and other information on a fatigue testing machine. **157**

High Temperature Furnace. Pereny Equipment Co., Inc., 2 pp. Specifications, advantages, and other information on a high temperature furnace for applications calling for long periods of sustained high temperature. **158**

Textile Testing. U. S. Testing Co., Inc., 6 pp, illus. General information on the services and facilities available for testing, research, and development of fibers, yarns, fabrics, garments, accessories, and finishes. **159**

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Technical-ities

By Fred E. Graves

Fastening of "blind hole" joints

Holes which don't go all the way through a solid member must be tapped, of course. In shallow, small holes, in non-critical fastening, and in soft materials thread cutting screws work well and save time.

But fastening large flanges, pressure plates, heads and the like to costly castings needs more precise production. These holes are ¼" diameter and larger, affect design strength.

THREAD EFFECTS

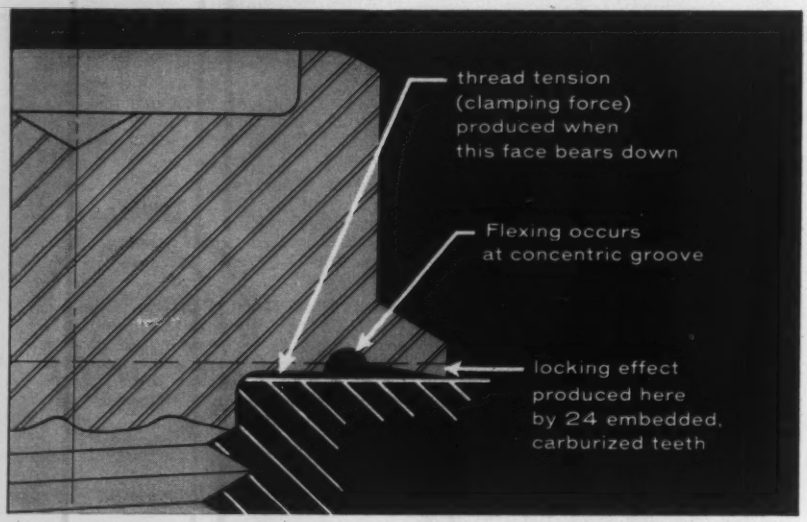
Such holes are coarse threaded. The coarse threads develop more thread strength than do fine threads, also take fewer turns in assembly. Studs go into the holes with an interference thread fit; hex screws with a simpler clearance fit.

Desirably, studs should all be driven to same depth and bottomed. Because of normal manufacturing differences, various mismatched high and low tolerances will cause studs to project unevenly. Assemblers often have to juggle. No such problem exists with hex screws. You just tighten to specified preload. And there's no double driving operation, as with stud plus nut.

STRENGTH OF BLIND JOINTS

Tapped holes behave like nuts. Their threads adjust elastically and plastically to distribute stress and develop high thread tension. Is this harmful in repeated disassemblies? Not at all. Hex screws have been installed 50 times in cast iron test blocks, then tightened to failure without damage to tapped holes.

Clamps like a hex screw Grips like an anchor



Tensilock® screws offer you the ideal combination of high clamping force and high locking power.

While a standard high strength hex screw can be tightened to a higher thread tension, its off-torque is less than its on-torque.

ANCHORED IN PLACE

The *"Tensilock"* screw features ratchet action teeth formed at an angle which will cut driving effort to permit you to utilize more of the full strength of screw. At equal driving torque, it not only develops 90% of the strength of a high strength hex screw but also takes *25% more torque to loosen than to tighten.*

Because of the flange's concentric groove, it flexes, allows the screw to bear down solidly on its seat and develop a high level of thread tension. At the same time the teeth embed themselves, are aided in maintaining their grip by pressure of the spring-action flange.

MAKES GOOD FRICTION-TYPE JOINT

Clamping force from Tensilock fasteners is sufficient to prevent slippage of fastened members where holes are oversize or eccentric. Grip of the teeth keeps fasteners tight under conditions of vibration or cyclic temperature changes. RB&W *"Tensilock"* Nuts also available. Write for Bulletin TL-2. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

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TECHNICAL LITERATURE

(cont'd from p 53)

Books

Organic Coating Technology, Vol. II: Pigments and Pigmented Coatings. *Henry F. Payne. John Wiley & Sons, Inc., New York. 1961. Cloth, 6 by 9¼ in., 1363 pp. Price $17.50*

This survey of the chemistry, manufacture and use of pigments and pigmented coatings is designed to be used with the earlier volume on oils, resins, varnishes and polymers.

Like its predecessor, this volume not only discusses the technology of coatings, but includes enough basic theory to provide a "working knowledge of the physics and chemistry of pigments and coatings." For example, the book covers the phenomenon of color and its measurement, and the relation of the hiding power of pigments to their physicochemical characteristics.

Some of the specific subjects covered include: fundamentals of pigmented coatings, white pigments, extender pigments, inorganic color pigments, black pigments, metal pigments and metallic stearates, principles of formulation and production, preparation of surfaces, methods of application, architectural paints, industrial finishes, and corrosion resistant and chemical resistant paint systems.

Zone Refining and Allied Techniques. *N. L. Parr. St. Martin's Press, Inc., New York. 1961. Cloth, 5½ by 8¾ in., 184 pp. Price $8.50*

This book deals with the practical, rather than theoretical, aspects of zone refining. Subjects covered include: the solidification process; molten zone refining; choice of equipment and examples; manipulation of high purity materials; chemical and physical examination of high purity substances; and the properties and applications of high purity materials.

The Encyclopedia of Microscopy. *Edited by George L. Clark. Reinhold Publishing Corp., New York. 1961. Cloth, 7 by 10¼ in., 693 pp. Price $25*

This companion volume to *The Encyclopedia of Spectroscopy* presents an authoritative, comprehensive survey of 26 different kinds of microscopy.

Beginning with a discussion of Autoradiography, and ending with X-Ray Microscopy, the reference volume contains over 140 articles specially written by outstanding international authorities on biological, medical, pharmaceutical, forensic, chemical, engineering, and industrial applications of microscopy.

Subjects of special interest include: crystal lattice resolution, dislocations in metals, textile fibers, metals by transmission, plastics, wear and lubrication, industrial research, hardness tests, particle size, and iron and steel.

Engineered Castings. *Glenn J. Cook. McGraw-Hill Book Co., New York. 1961. Cloth, 6 by 9 in., 240 pp. Price $8.50*

This book emphasizes the use of castings rather than the production of castings. Major subjects covered include: 1) How To Use Castings (advantages and limitations, present uses, and future opportunities); 2) How Castings Are Made (sand molding, shell molding, investment casting, permanent molding, die casting, inspection and testing, etc.); 3) How To Select The Metals (gray iron, malleable iron, ductile iron, vacuum treated metals, and nonferrous metals); 4) How To Design Castings (soundness, cost, tolerances); and 5) How To Buy Castings.

Of special interest are the discussions on complexity of parts, maximum and minimum size, mechanical properties, surface detail and smoothness, and precision and tolerances.

Manual of Man-Made Fibers. *C. Z. Carroll-Porczynski. Chemical Publishing Corp., New York. 1961. Cloth, 5½ by 8¾ in., 304 pp. Price $10*

This concise, authoritative manual is a summary of available technical information on the manufacture, properties, identification, and availability of man-made fibers.

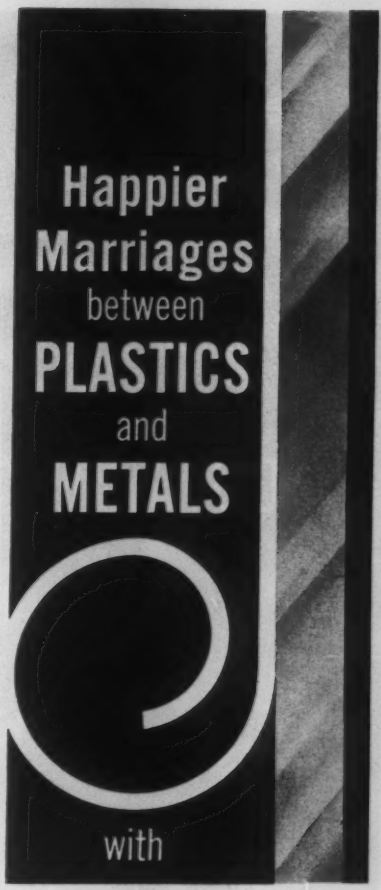
Except for the introductory chapter on world production and classification, the book consists primarily of a series of tables, charts, and diagrams listing: 1) physical, chemical, and electrical properties; 2) flow diagrams of manufacturing processes; and 3) stress-strain curves.

The book concludes with a series of over 120 photomicrographs and x-ray diffraction patterns, and a comprehensive bibliography.

Reports

High strength steels THE STATUS OF RESEARCH AND DEVELOPMENT FOR HIGH STRENGTH AIRCRAFT STEELS. *Lt. Col. E. N. Kennedy, USAF. Materials Central, Wright Air Development Div., U. S. Air Force. July '60. 86 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.00 (PB 171 077)*

This report outlines the areas of



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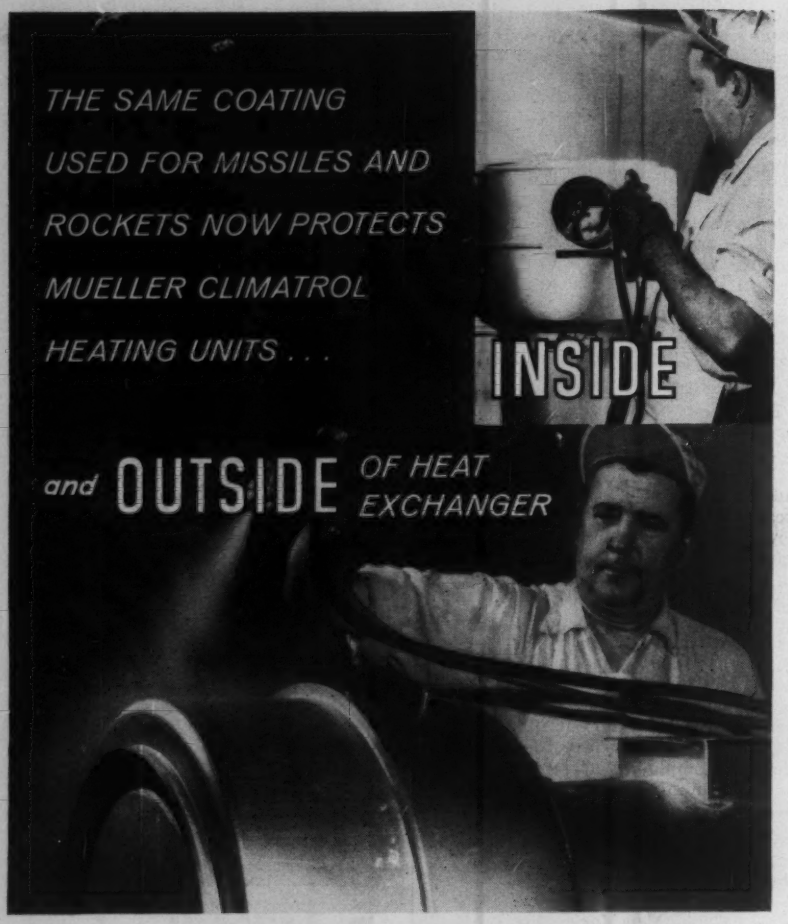
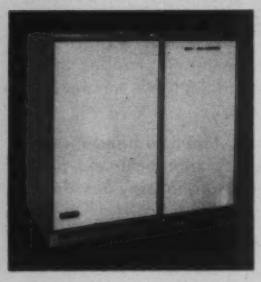
The Skill of Making Things Stick

For more information, circle No. 414



SICON® Protects against 1000°F.



Mueller Climatrol Type 119 gas fired heating units. In four sizes—110,000 to 175,000 BTU input capacity.

Sicon "Endural" protects the heat exchanger *both inside and outside* of all Mueller Climatrol gas fired models in the 119/219 line of heating units.

Sicon was adopted because its silicone base makes it resistant to sustained high temperatures —up to 1000°F.—without peeling or flaking, as proved in actual use on rockets, missiles, and jet aircraft components. And Mueller Climatrol engineers report it also prevents rust and corrosion. This 4-way protection assures much longer life for all Mueller Climatrol units and multiplies user satisfaction.

Sicon in aluminum and in smart decorator colors has solved *many* coating problems involving sustained heat. Write for latest Sicon brochure and specifications. Test data will be supplied without obligation. Write Dept. H-I.

Sicon®

SILICONE BASE HIGH HEAT RESISTANT FINISH

MIDLAND INDUSTRIAL FINISHES COMPANY
WAUKEGAN, ILLINOIS
ENAMELS SYNTHETICS LACQUERS VARNISHES

For more information, turn to Reader Service card, circle No. 399

TECHNICAL LITERATURE

investigation where significant efforts are being made to improve and develop steels with optimum strengths and ductility over a wide range of temperatures. The two general groups of high strength steels surveyed are the low alloy steels and the stainless steels. The report includes sections on chemical composition, processing techniques, investigations by users and producers, development of heat treatable filler wires, and arc welding of high strength steels for aircraft and missile structures. A bibliography is included.

Beryllium properties MECHANICAL PROPERTIES OF BERYLLIUM. *A. E. Risen and R. T. Ault. Wright Air Development Div., U. S. Air Force. Sept '60. 37 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.00 (PB 171 411)*

Reports a study of the mechanical properties of hot pressed and hot pressed–hot extruded beryllium. Both types of parts showed surprising strengths under fatigue loading conditions. The hot pressed–hot extruded beryllium, however, was uniformly stronger and therefore seems to offer greater potential for structural applications in aircraft.

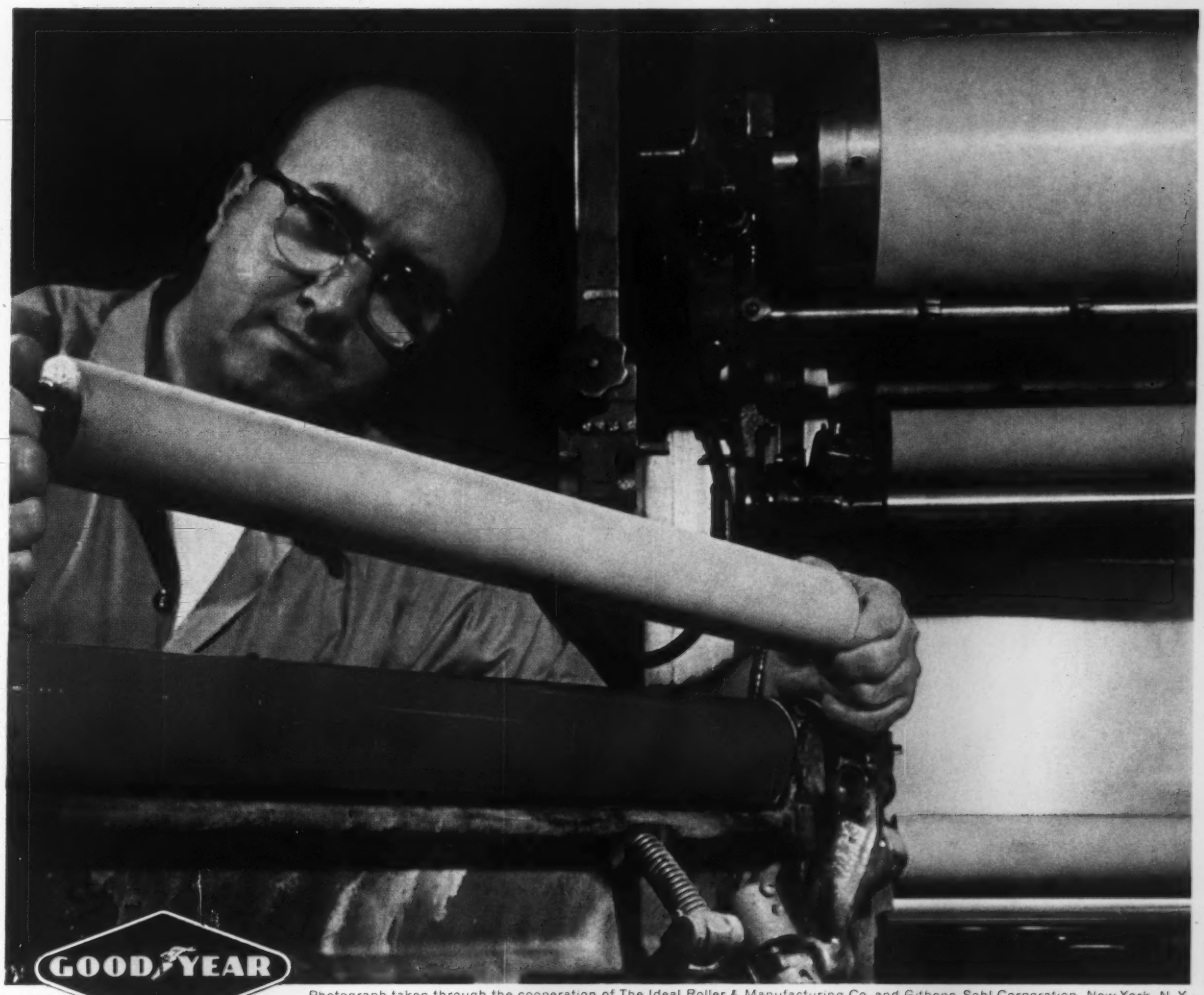
Standards abbreviations STANDARDS AND SPECIFICATIONS — DOCUMENT SYMBOLS AND ABBREVIATIONS. *John T. Milek. Standard Engineers Society, Inc. 1961. 10 pp. Available from Standards Press, 8417 Reading Ave., Los Angeles 45, Calif. Price $1.50*

Lists about 500 symbols and abbreviations for domestic and foreign standards and specifications which should be of aid to design engineers, draftsmen, specification writers and standards engineers.

Uncommon machining methods REVIEW OF SOME UNCONVENTIONAL METHODS OF MACHINING. *Defense Metals Information Center, Battelle Memorial Institute. Nov '60. 20 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price 50¢ (PB 161 225)*

Principles and applications of four novel electrical machining techniques. The techniques can be used as alternatives to conventional machining methods for processing materials such as carbides, ceramics and high strength, heat resistant alloys that are difficult to cut. Chemical and ultrasonic machining methods are also covered.

For more information, circle No. 424 ➤



Photograph taken through the cooperation of The Ideal Roller & Manufacturing Co. and Githens-Sohl Corporation, New York, N.Y.

They multiply inking roller life 16 times—with CHEMIGUM

Each new season used to call for new inking rollers on "job" printing presses. Glue composition rollers would swell, soften—even melt—in hot and humid weather. And they would shrink and harden in cool, dry weather. Valuable time was lost, printing quality varied.

A leading roller manufacturer found CHEMIGUM N-8 a year-round answer to the problem. CHEMIGUM N-8 effectively resists climatic changes. Its soft, smooth surface means proper ink pickup and release. Its oil- and solvent-resistance makes it more durable, easy to clean. What's more, CHEMIGUM is extremely easy to process, keeps costs down. And the new rollers last—not a season—but up to 4 years!

How can CHEMIGUM rubber or latex help you improve your product or enter a new market? Full details plus expert technical assistance are yours at Goodyear Chemical Division, Dept. H-9437, Akron 16, Ohio.

Lots of good things come from

GOODYEAR

CHEMICAL DIVISION

Chemigum—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

"We had 18-20 hours downtime every time we changed heats. With strip, we just hook on from heat to heat. No downtime."

"With strip we use smaller blanks to produce the same part."

"By using strip we save downtime, die repairs."

"Rejects have dropped from about 8% to less than 1%."

"We found we couldn't afford the low cost of sheet."

Read why Target Stamped Products, Inc., Kinsman, Ohio, switched from strip to sheet—and then back to strip. Comments are Harvey Haynman's, Target's president:

"We thought we'd give sheet a try back in 1958. The low cost looked too good to pass up. Today, you'd have a hard time finding a piece of cold rolled sheet around the shop.

"We were absorbing 18-20 hours of downtime every time we changed heats. With strip, we just hook on from heat to heat. The characteristics are the same from heat to heat and coil to coil. We don't waste time adjusting our dies.

"Strip saves us metal. We can use smaller blanks to produce the same part. I'd say we save from 1/16" to 3/32" of metal per part. That's a lot of steel when you're turning out 25-30 million parts a year.

"We don't have gauge problems now. The strip we buy is always rolled within our working tolerance. We work to a plus or minus .0025 inches.

"So far, strip hasn't given us lamination troubles. It doesn't take much lamination to give you big trouble in a deep drawing operation. When the metal separates, part may stick to the punch while part stays in the cavity. As another blank transfers to the same station, there's a double smash and the die is ruined. That hasn't happened with strip. Saves a lot of downtime and die repair.

"Strip takes a deep draw without thinning out on you. Its uniform temper pays off when you're turning out Silent Blocks where both the ID and OD have to be right or the part's a reject.

"All in all our rejects have dropped from about 8% to less than 1% since we switched back to strip.

This mark tells you a product is made of modern, dependable Steel.

Outer metal bushing of a Silent Block. Target Stamped Products turns out millions of these each year for the auto industry. Silent Blocks are used in the suspension systems of all American cars—about eight to a car. To produce the piece, Target must work to a plus or minus .0025" tolerance or the Silent Block won't work. When Target switched back to strip, their rejects dropped from about 8% to less than 1%.

"You can have all the automation in the world, but if you're using the wrong steel, it just nickels and dimes you to death. With strip our machines keep working; we need less supervision, less tool repair. Our trim is small and our percentage of rejects is the smallest we've ever known. We found out we couldn't afford the low cost of sheet. That's why we're back with strip."

The switch is back to strip

Cold rolled sheet steel can be your best buy on a cost per pound basis. Certainly its quality has risen sharply since the war. But, pound cost is only part of the story. If you really need steel tailored to your specific production requirements, cold rolled strip is the answer.

Strip is not sold on an as-rolled basis. What you buy is a specific chemistry, temper, dimension, edge and finish to precisely meet your fabricating and end-use requirements.

American Steel and Wire has over 12,000 mill practices in available strip specifications. Many of your processing steps may actually be eliminated by using cold rolled strip.

Take a hard look at your production line and let our salesmen look with you. Check your rejects, your downtime, your scrap rate. Perhaps you can improve the quality of your product and cut production costs at the same time, with *tailored-to-the-job* cold rolled strip from American Steel and Wire. American Steel and Wire Division, Rockefeller Building, Cleveland 13, Ohio. USS and American are registered trademarks

American Steel and Wire Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
Tennessee Coal and Iron Division, Fairfield, Ala., Southern Distributors
United States Steel Export Company, New York, Distributors Abroad

For more information, turn to Reader Service card, circle No. 444

For more information, circle No. 422

NOW... Design with the most paintable–durable–weldable zinc-coated steel yet produced

...NEW ARMCO

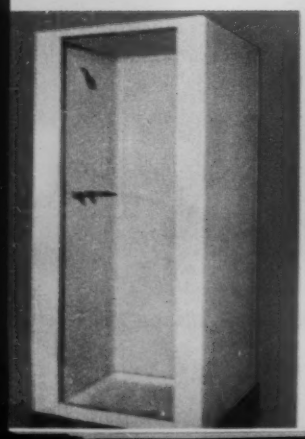
Spangle-free Armco ZINCGRIP® A, PAINTGRIP® is a zinc-coated steel especially prepared to take an ultra-smooth, lasting paint finish immediately after fabrication.

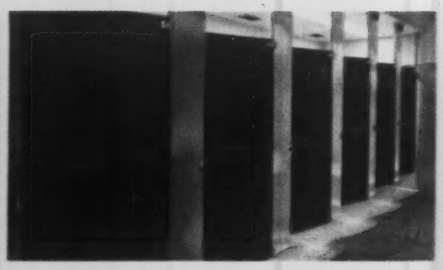
You can design for top durability. Three years of outdoor tests show paint adherence and life on ZINCGRIP A, PAINTGRIP is superior to phosphate-treated cold-rolled steel and to all zinc-coated steels prepared for painting. Its zinc coating keeps rust away when paint is damaged—protects from corrosion where there's no paint at all.

This new Armco steel is ideal for welded designs. *Twice as many spot welds* can be made as on ordinary galvanized steel before electrode tips need redressing. And it's every bit as workable as Armco ZINCGRIP, the zinc-coated steel that has proved itself in severely-fabricated products for more than a quarter-century.

New Armco ZINCGRIP A, PAINTGRIP is available *now* in gages from 16 to 24, with 1.25 oz. per sq. ft. class coating or light commercial coating, in cut lengths and coils up to 48 inches wide, depending on gage. Write for details. Armco Division, Armco Steel Corporation, 1971 Curtis Street, Middletown, Ohio.

ARMCO Armco Division

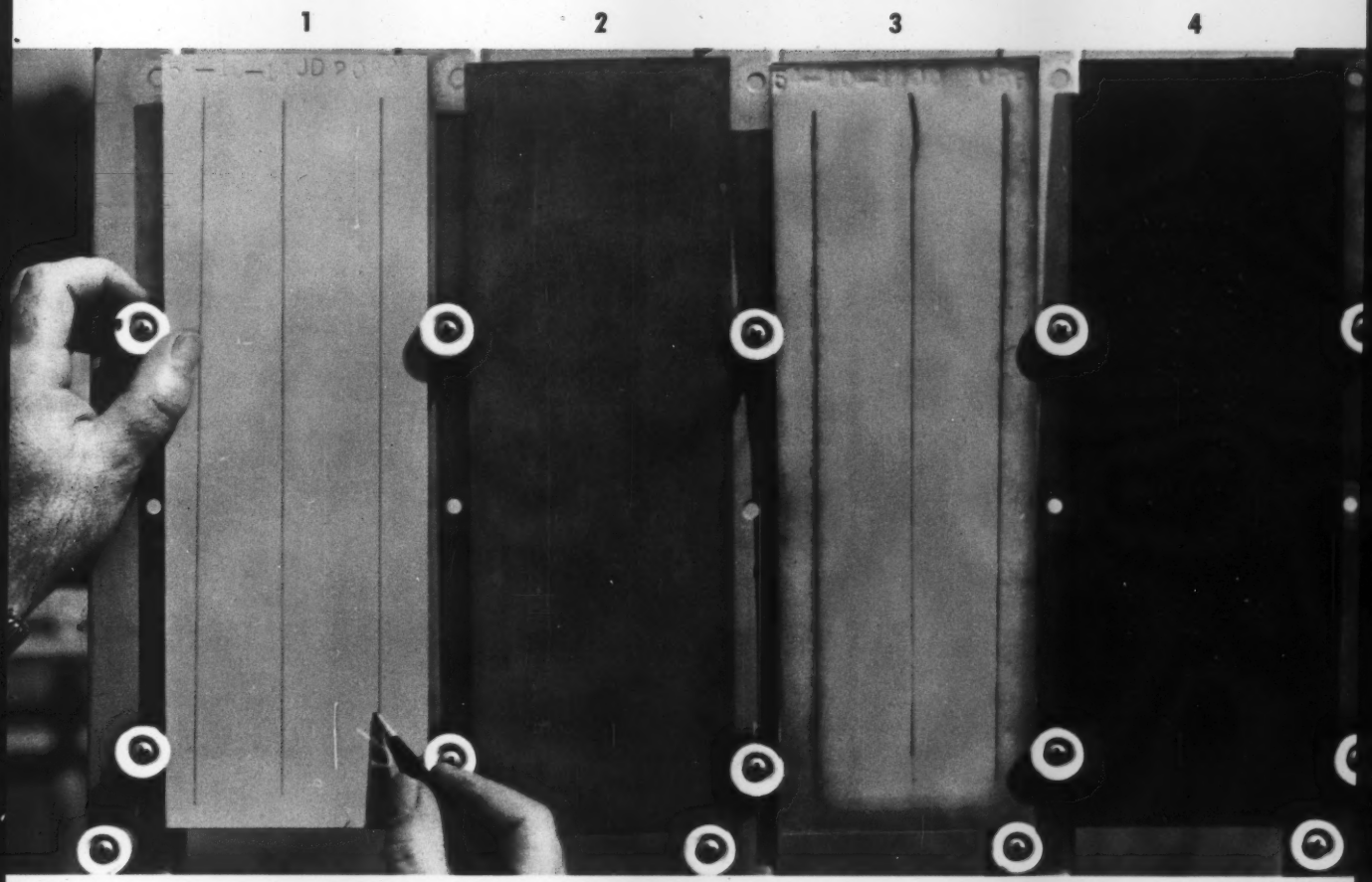




Rust-resistance and spangle-free paintable surface mean lasting good looks in applications such as these.

New steels are born at Armco

ZINCGRIP A, PAINTGRIP



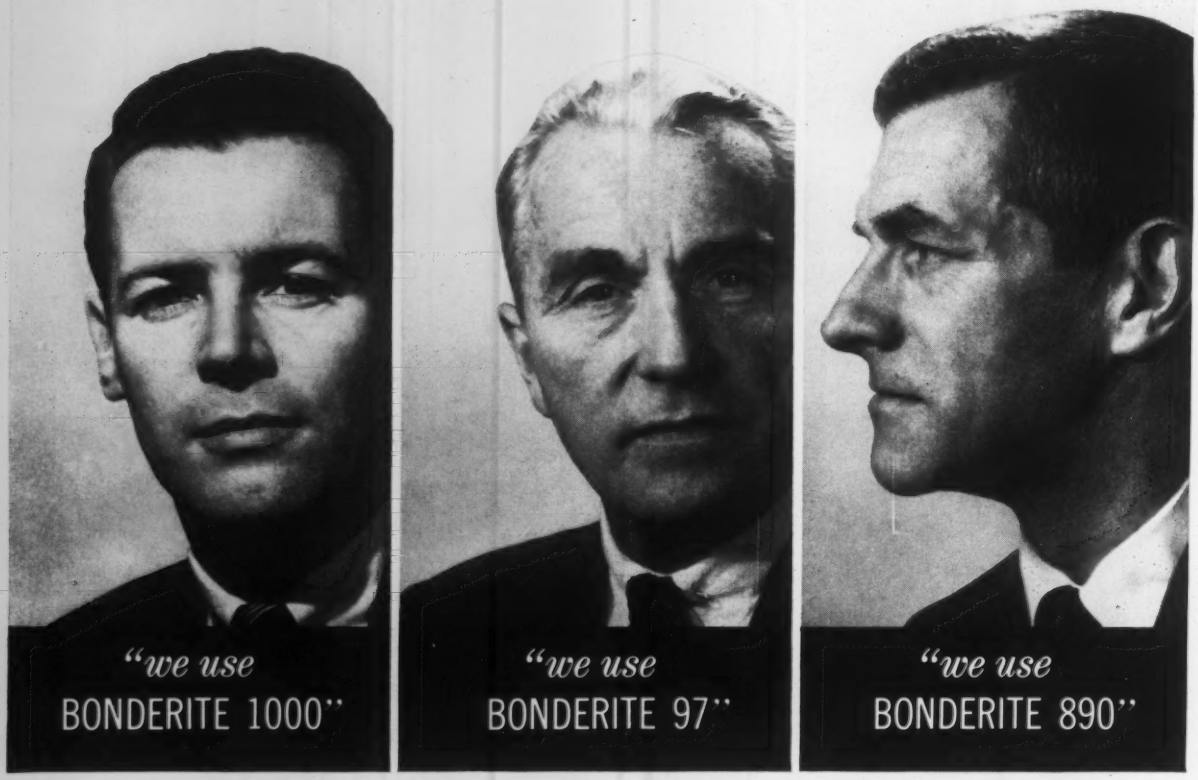
This half-painted bus body fabricated from Armco ZINCGRIP A, PAINTGRIP has been exposed for 2½ years. Paint finish is still smooth and attractive, the unpainted surface rust-free.

After 3-years' exposure outdoors, paint holds tightly to sample of Armco ZINCGRIP A, PAINTGRIP (1), even where scratched at start of test. Where unpainted (2) there's no rust either. In contrast, painted and unpainted phosphate-treated cold-rolled steel panels (3 and 4) are in poor condition. Paint has been undercut. Rust is entrenched.

Galvanized Steel

Use this label to point out durable zinc-coated steels in your products

Three manufacturers with similar products—



There are 57 different Bonderites for metal

one of them is the right paint base for you

Parker long ago realized that any "universal" phosphating treatment would at best be a compromise. A "universal" treatment can't possibly meet the individual conditions and requirements in any one plant as exactly as can a Bonderite that is formulated with that plant's finish line needs in mind.

Parker has many phosphating treatments (38 of them for steel alone), has trained its representatives to match the right Bonderite to a customer's total requirements, and invests hundreds of thousands of dollars in research and development to keep ahead of the ever-changing finishing demands of modern industry.

Don't compromise on quality with a "universal" treatment when Parker can give you a *Bonderite* that's right for *you*.

PROTECTED BY Bonderite PARKER RUST PROOF CO. QUALITY CORROSION RESISTANT

Parker Rust Proof Company
2173 E. MILWAUKEE, DETROIT 11, MICHIGAN

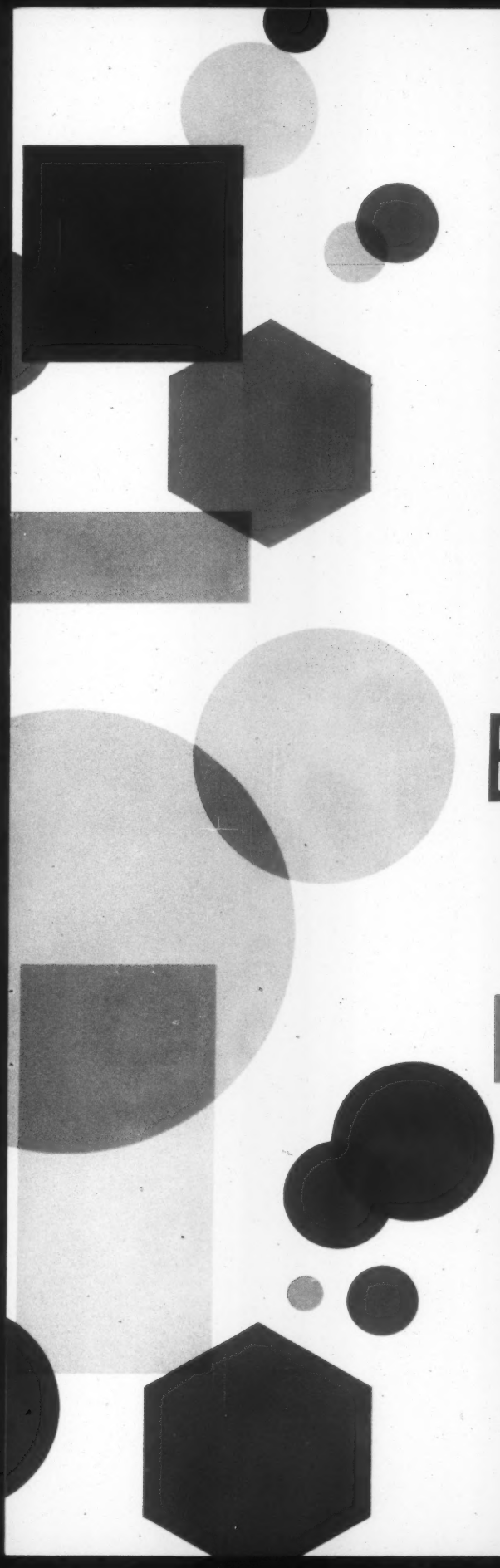
BONDERITE corrosion resistant paint base • BONDERITE and BONDERLUBE aids in cold forming of metals • PARCO COMPOUND rust resistant • PARCO LUBRITE—wear resistant for friction surfaces • TROPICAL—heavy duty maintenance paints since 1883

Since 1914—Leader in the field

*Bonderite, Bonderized, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.

For more information, turn to Reader Service card, circle No. 341

For more information, circle No. 420 ➤



New
Allegheny Stainless
Bar Program
Means . . .

FAST DELIVERY

BETTER MACHINABILITY

UNIFORM IMPROVED PROPERTIES

TOP QUALITY PROCESSING

FAST DELIVERY—

5,000,000 lbs. of finished bars
8,000,000 lbs. of semi-finished stocks
to back-up distributor inventory

Allegheny Ludlum now stocks at the mill depots, Rounds, Hexagons, Squares, Flats and Forging Billets in the ten most popular grades that account for over 85 percent of all stainless bars made. This huge stock of over 2,500 tons backs up the large inventories carried by the authorized Allegheny Ludlum Distributors.

In addition to the finished stock, over 4,000 tons of quality checked rerolling billets and ingots in 30 grades are in inventory to cut delivery time and to insure predictability.

Each month, A-L publishes a Bar, Wire, and Forging Billet Stock List which lists the grades, sizes, and actual pounds of each in stock at the first of that month. It's available to you through the Steel Service Centers authorized to sell A-L Stainless Bars. For the names of the distributors in your area, just call the A-L District Office.

BETTER MACHINABILITY—

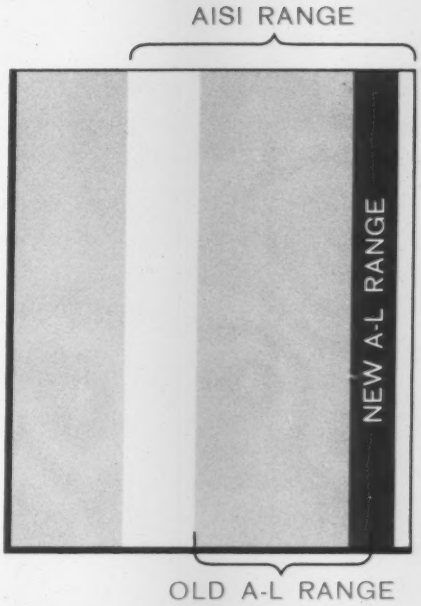
Research, Constant Testing and Controlled Processing Result in Greatly Improved Machinability and Uniformity . . . from Lot to Lot

Several years ago, A-L took a hard look at its own stainless steel bars. While quality was good, it could be made better and more uniform, particularly in the area of machinability.

One of the finest metalcutting laboratories in the country was retained to make independent, exhaustive comparative tests on A-L stainless bars and competitive bars. Ratings were based on tool life, determined by turning and drilling tests. A-L's Research Center, probably the largest in the stainless business, correlated these results with metallurgical factors such as composition, microstructural and mechanical properties.

From Research to the melt shops went instructions to revise and narrow the limits of composition. This, combined with processing changes, yields general purpose (stocked) grades with predictable, better machinability.

RESULT: Testing general purpose machining grades as made three years ago with the same grades made today shows better than a 50 percent increase.

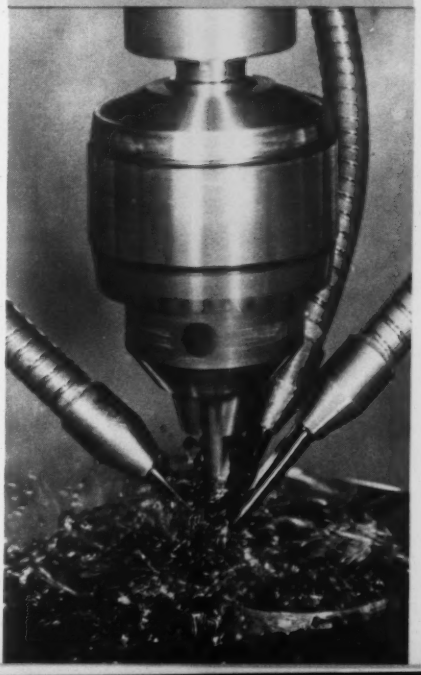


ANALYSIS LIMITS

Allegheny Stainless composition limits, already much tighter than AISI Specifications, have been narrowed even further to improve the composition-sensitive machining properties of all A-L Stainless Grades.

MACHINING TESTS

Exhaustive turning and drilling tests on stainless bars of all types pin-pointed the composition and processing variables that most affected machining properties, and made possible the adjustment of these variables for improved machinability and predictability of response from heat to heat. A continuing program of these machining trials serves as an additional safeguard to the quality and unmatched dependability of an A-L Stainless Bar.



TOP QUALITY PROCESSING—

Special Care and Special Equipment Mean Better Bars at Your Machines

What's been your big trouble with cold finished stainless steel bars . . . nicks and gouges, off-size, burred ends, grinding marks, damaged shipments? Glance over the panels at the right, and see how these common faults are eliminated from Allegheny Ludlum cold finished stainless bars.

These are precautions that make a difference between an A-L quality bar and all the others . . . quality you can see, and feel, and measure. Quality that shows up in bar automatics, in all your fabricating.

And this quality is no accident. A few years ago, Allegheny Ludlum investigated stainless bars from the customer's viewpoint. A-L teams held field interviews, toured customer's plants, watched stainless bars undergoing every conceivable fabricating operation. A good part of the trouble was in mill finishing. And A-L revamped their entire finishing operation to suit.

Special equipment is installed, and every operation becomes a matter of painstaking care. Rubber padding covers every work table and inspection table, lines every transfer buggy . . . chain and cable slings are eliminated, and soft rope substituted . . . cardboard collars are fitted to bars in process, to prevent rubbing and scratching.

Quality Audit Teams continually audit and maintain quality control standards by making pinpoint quality checks through every phase of production . . . right onto the shipping dock.

Many of these practices have been widely imitated in the industry. Some are still A-L exclusives. But, this is how quality is made . . . stainless steel bar quality . . . by the world's leading stainless steel producer.

HEAT NUMBERS ON EVERY B

Heat numbers stamped perm
end of the bar won't wear off
rated. Square, clean-cut and
make use in bar automatics e
chucking simpler.

CONSISTENT SIZE AND STRAIGHTNESS TOLERANCES

A-L's famous quality control and inspection procedures mean greater uniformity . . . minimizes special handling in your plant.

NICK-FREE, SCRATCH-FREE BARS

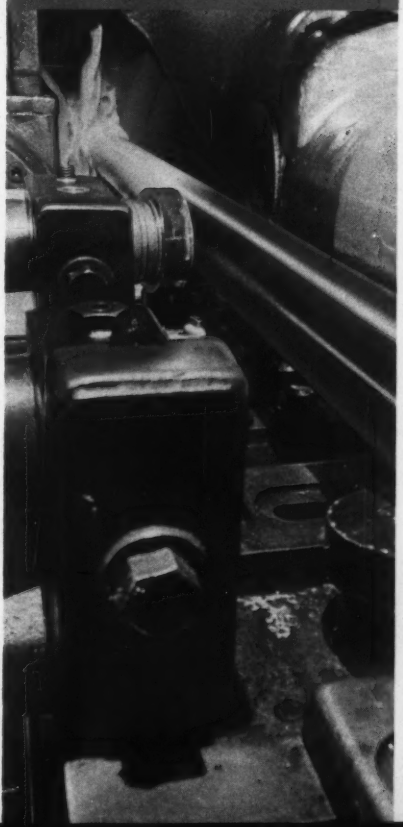
Nothing harder than cardboard, ropes or rubber ever touches finished A-L bars. Cardboard collars eliminate sliding, metal-to-metal contact . . . chain or cable are never used.

BAR

rmanently on one off, can't get sepand deburred ends s easier and make

CAREFUL FINISHING PAYOFF

Multiple passes through centerless grinders result in smooth finish—no spiral grind marks —no chatter marks.



PROTECTED SHIPMENTS

All bars are protected with cardboard collars and then the bundle is completely wrapped with triple-thickness waterproof paper to protect the superior finish during shipment. Reduces damage in transit.

SMOOTHEST FINISH AVAILABLE

Consistent metal quality and careful finishing result in a surface vastly superior to the industry-accepted average standard.

And if You Want Something Special A-L is a Complete Bar Source

HIGH TEMPERATURE STEELS & ALLOYS

A-L stocks certain finished bars in the most commonly used high temperature steels and alloys plus a large stock of approved billets in these same grades. Needs for bars of A-286, 19-9DL, AM-355, Waspaloy, AL 901, R 41, S-816, M-252, etc., are usually quickly satisfied from this finished and semi-finished stock of Allegheny Ludlum.

FORGING BARS & BILLETS

Also in stock is a full range of forging-quality bars and forging billets from 4 to 30 inches Round Cornered Squares in a wide range of grades, all meeting appropriate specifications.

SPECIAL ANALYSIS AND PROCESSING

For special requirements, A-L is able to tailor-make properties to fit the end use. From knowledge gained in the machining research program, chemistry and processing can be varied to increase a specific property for a particular application. Improvements in such things as hot workability, cold workability, hardenability, finish after machining, improved machinability in non-free machining steels, mechanical properties, corrosion resistance, are examples.

It's something you should discuss with your A-L sales representative.

MACHINING AND HEAT TREATMENT DATA

A-L mill and research specialists are available, through the A-L sales representatives, for help and counsel on problems involving Allegheny Stainless Bars. Qualified machining engineers are at your service. These men devote their full time to provide the best service and assistance available anywhere.

NEW BAR BOOKLET

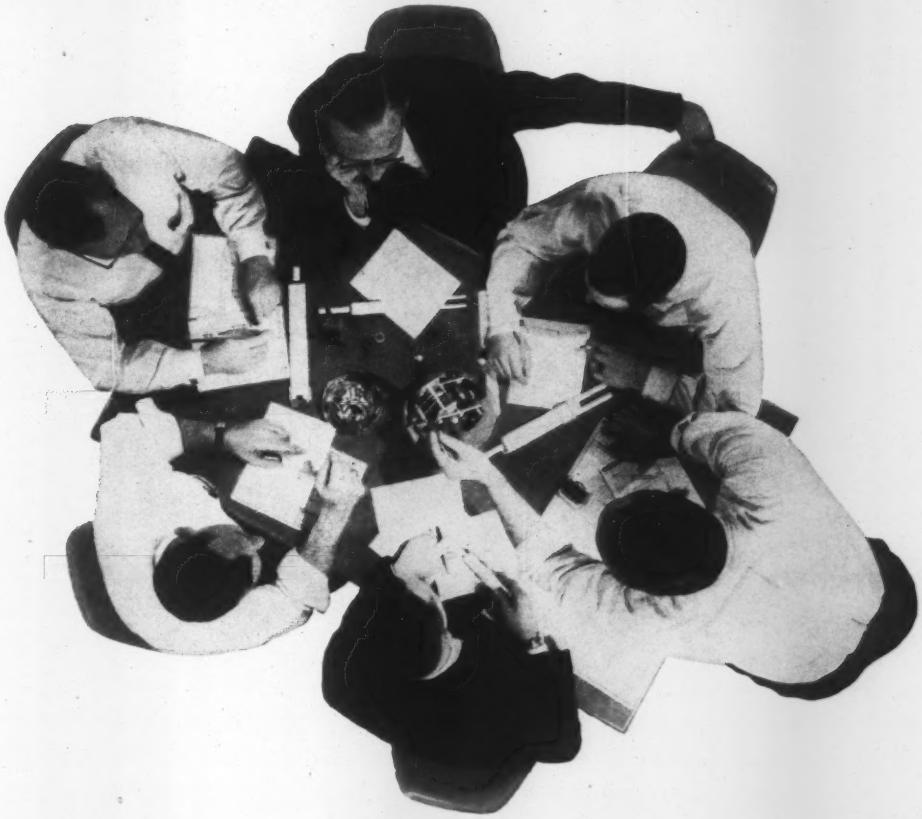
On the printing press now is A-L's new booklet, jam-packed with helpful information on using, heat treating and machining Stainless Bars. For a copy of this technical, data-filled booklet, check the A-L authorized distributor in your area, or the A-L Sales Office nearest you, or write: ***Allegheny Ludlum Steel Corporation, Department QIP 3, Oliver Building, Pittsburgh 22, Pa.***

ALLEGHENY LUDLUM

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

3473

LOWER PRODUCTION COSTS START HERE



...with Spaulding Value Analysis Engineers putting their heads together over your product

Spaulding interprets the Value Analysis Process as "a scientific method of accomplishing a function at the lowest possible cost."

That's why Spaulding maintains specially trained Value Analysis Engineers on its sales staff who evaluate a customer's product, then decide how it can be made better, easier, and at a lower cost through the use of a Spaulding material processed by Spaulding's own Fabricating Department.

These men save Spaulding's customers thousands of dollars annually. Why not let them put their heads together for you?

The Unique Characteristics of these Spaulding Materials and Services Hold Important Advantages for your product.

Spaulding Vulcanized Fibre: Hard, dense, extremely wear-resistant. One of the best arc-resistant, electrical and heat insulators known to industry.

Spauldite: Industrial plastic laminates.

Spauldo: A 100% rag paper electrical insulation used as motor slot insulation.

Spaulding T: A very high grade fibre board. Also known as Pressboard, Transformer Board and Fuller Board.

Spaulding Armite: An improved thin vulcanized fibre insulation (fish paper).

Spaulding Fibre Board: Made by the wet process from selected fibrous materials in various grades, including resin boards.

Fabrication Facilities: Undivided responsibility from manufacturer to finished part, with the most complete fabricating facilities in the industry.

SPAULDING FIBRE COMPANY, INC.

333 WHEELER STREET, TONAWANDA, NEW YORK

For more information, circle No. 420

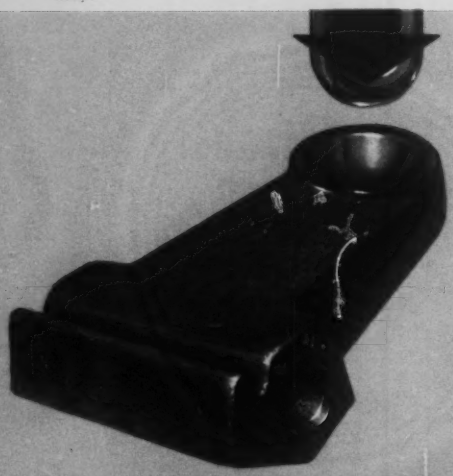
For more information, turn to Reader Service card, circle No. 321

Post-Forming: New Way to Bigger Savings with Malleable Castings

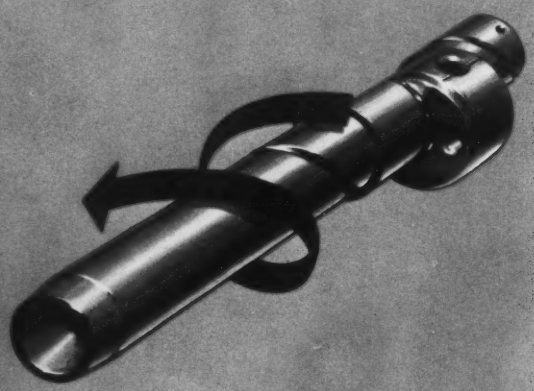
The ductility of Malleable iron castings permits use of high-speed forming techniques to finish Malleable parts at lower cost. Take advantage of the versatility you get only with ferritic and pearlitic Malleable castings. For a fuller understanding of how Malleable can help you, call any producer that displays this symbol —

Free Folder describing these techniques is available for your use. Just ask any member of the Malleable Castings Council for Data Unit No. 116, or write to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

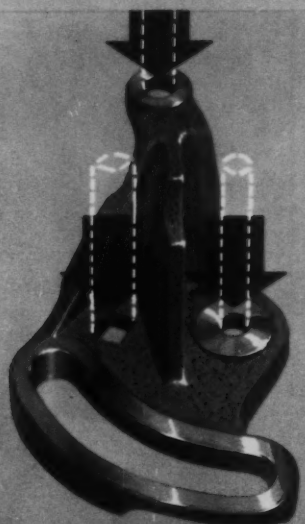
MEMBER
MALLEABLE
CASTINGS COUNCIL



Hot Form It — Hot coining this Malleable transmission part reduces finished cost . . . eliminates three cutting operations required by the previously used steel part.



Roll It — Oil grooves in lawnmower crankshafts and splines in compressor crankshafts are just two of many places where rolling proves more economical than machining.



Punch It — Holes with diameters greater than the thickness of the metal can be punched in Malleable. Two round holes and a square hole are punched simultaneously in this idler arm.

Spin It — Malleable's ductility permits the sleeve and end disc in this ball joint to be held in place by spinning the Malleable housing into a strong, permanent flange.

Get the most for your metals dollar...get MALLEABLE

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Iron Works, Moline
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Albion Malleable Iron Company, Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Mall. & Steel Castings Co., Indianapolis 22

IOWA
Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI
Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

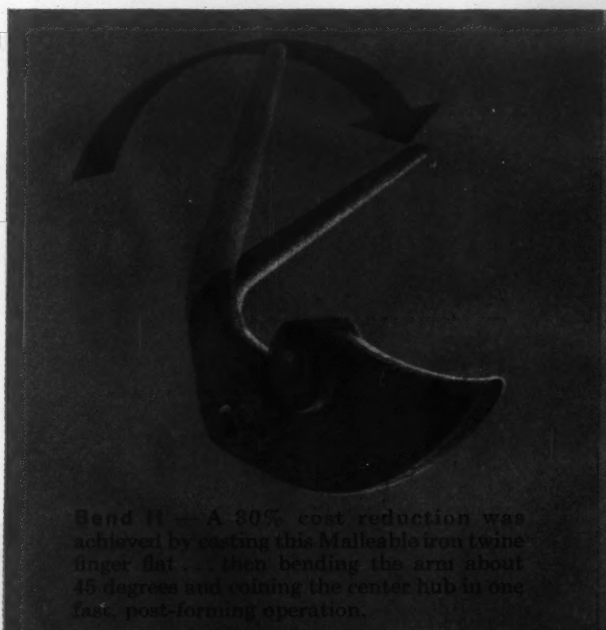
OHIO
American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

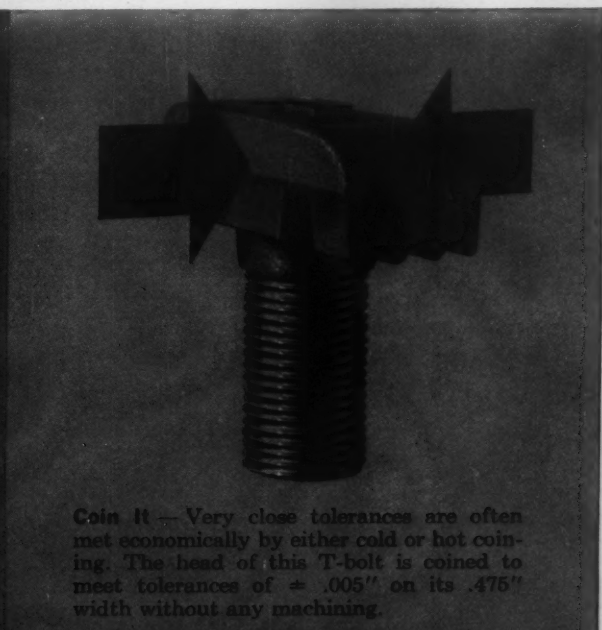
TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

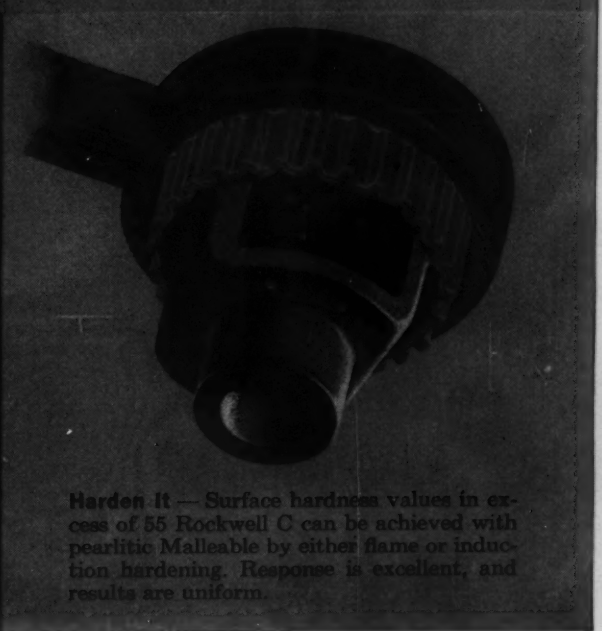
WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46



Bend It — A 30% cost reduction was achieved by casting this Malleable iron twine finger flat . . . then bending the arm about 45 degrees and coining the center hub in one fast, post-forming operation.



Coin It — Very close tolerances are often met economically by either cold or hot coining. The head of this T-bolt is coined to meet tolerances of ± .005" on its .475" width without any machining.



Harden It — Surface hardness values in excess of 55 Rockwell C can be achieved with pearlitic Malleable by either flame or induction hardening. Response is excellent, and results are uniform.

For more information, turn to Reader Service card, circle No. 332

GRAPHITAR®

(CARBON-GRAPHITE)

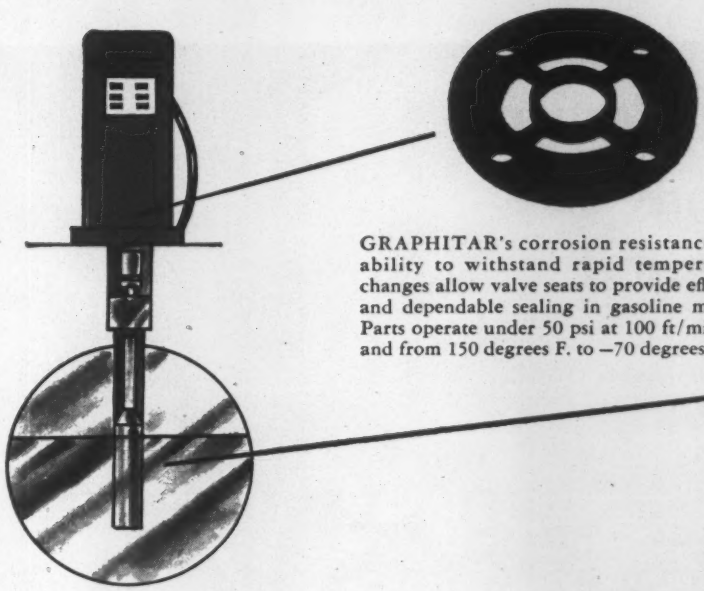
FOR PERFORMANCE

Superior performance and unusually long service life, even in tough applications, is practically second nature to parts made of GRAPHITAR. That's because they combine GRAPHITAR's chemical stability, heat resistance, low coefficient of friction, adaptability to self-lubrication, mechanical strength, hardness and light weight. An everyday application of GRAPHITAR that illustrates well its versatility and remarkable performance can be found in the face-type valves employed in bulk station gasoline meters.

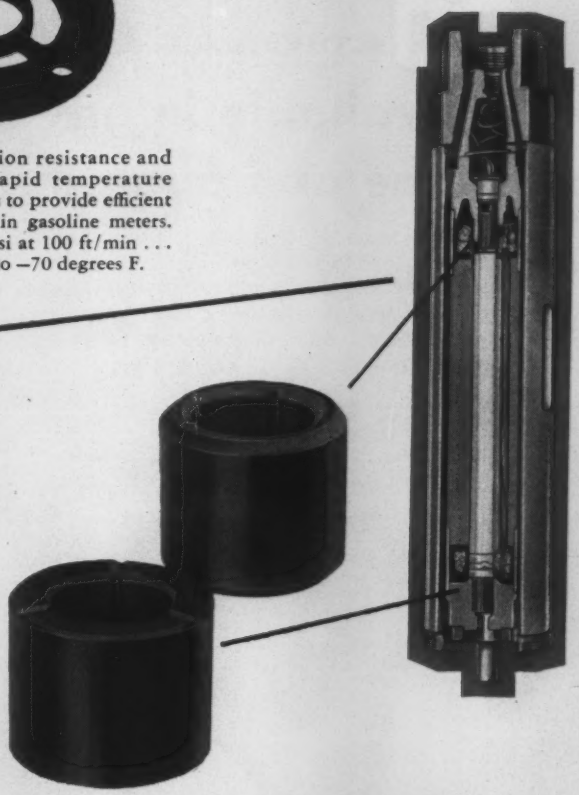
These valves incorporate GRAPHITAR seats. Here, GRAPHITAR's corrosion resistance, chemical inertness and resistance to expansion or contraction under rapid temperature changes, allow the valves to provide a leak-tight seal with excellent wear characteristics. These same characteristics are necessary for good performance wherever steam, gas and chemicals must be handled under the most adverse conditions. Perhaps your product can benefit from the top performance of GRAPHITAR, a unique and versatile engineering material.

Comparative testing of various grades of GRAPHITAR self-aligning seals is accomplished on this equipment, which duplicates actual operating conditions. GRAPHITAR rotary pressure joint seals such as these often operate at 400 psi, at 650°F. and at rotary speeds of 600 ft/min.

Tests show that the compressive strength of GRAPHITAR grades varies from 4,500 to 45,000 psi. Correct part design can take advantage of this desirable characteristic to aid part performance.

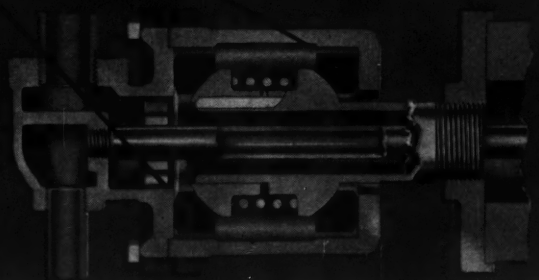


GRAPHITAR's corrosion resistance and ability to withstand rapid temperature changes allow valve seats to provide efficient and dependable sealing in gasoline meters. Parts operate under 50 psi at 100 ft/min . . . and from 150 degrees F. to —70 degrees F.



Running directly in the gasoline reservoirs below ground level, a submersible, explosion proof pump depends on two GRAPHITAR bearings to keep its operation safe and smooth. GRAPHITAR is non-metallic, will not weld or score even when in contact with a dry metal shaft. Because GRAPHITAR operates with *any* liquid as a lubricant, it is an ideal bearing material wherever low viscosity liquids such as gasoline are encountered.

Self-aligning seals of GRAPHITAR are employed in rotary pressure joints handling steam, water, hot oil, trichlorethylene, powdered talc and a variety of chemicals. GRAPHITAR has the ability to withstand the action of many such chemicals and only very highly oxidizing reagents in hot and concentrated form can react to destroy GRAPHITAR.



GRAPHITAR is a material uniquely designed by its nature for solving tough problems and improving processing, and it can be further custom-engineered to meet your exact specifications. For complete information on GRAPHITAR . . . send for Engineering Bulletin #20.

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 3, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

For more information, turn to Reader Service card, circle No. 363

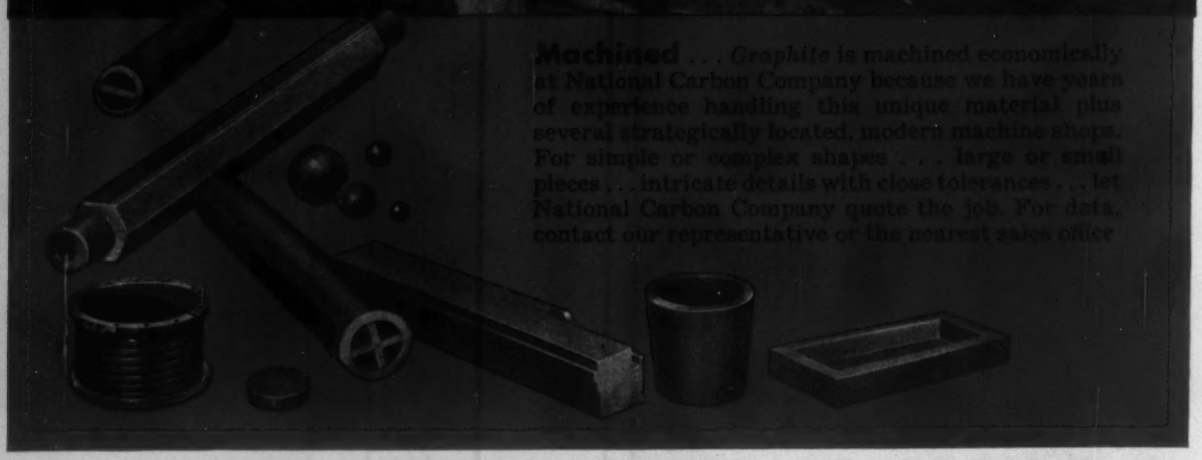
R-299-2

NATIONAL GRAPHITE

is available in any size, shape and quantity!

Unmachined... *Graphite* is available from minute particles to five ton blocks...in all sizes of square, round, rectangular and cylindrical shapes. Whatever your needs—whether quantity, purity or size... made from standard or special grades—let National Carbon Company quote on your requirements.

Machined . . . *Graphite* is machined economically at National Carbon Company because we have years of experience handling this unique material plus several strategically located, modern machine shops. For simple or complex shapes . . . large or small pieces . . . intricate details with close tolerances . . . let National Carbon Company quote the job. For data, contact our representative or the nearest sales office



"National" and "Union Carbide" are registered trade-marks for products of

NATIONAL CARBON COMPANY
Division of Union Carbide Corporation • 270 Park Avenue, New York 17, New York
IN CANADA: Union Carbide Canada Limited, Toronto

UNION CARBIDE

For more information, turn to Reader Service card, circle No. 395

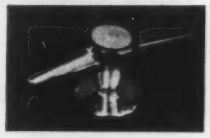
SPECIFY TENZALOY FOR:

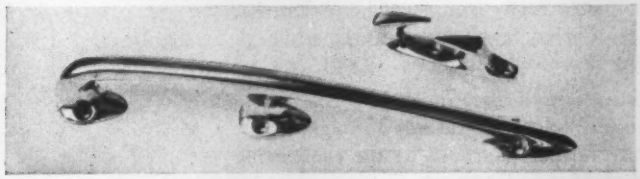
BRILLIANT FINISH AND SHARP DETAIL IN HIGH STRENGTH CASTINGS

Tenzaloy aluminum castings take a brilliant polish, anodize clear white and can be dyed in a wide range of decorative colors. Tenzaloy casts easily for sharp detail and complex shapes. Its great strength in thin cross section makes possible an extremely wide variety of products combining beauty and utility.

Special techniques are not required for handling this high grade alloy in the foundry... and it needs no heat treatment. Tenzaloy ages at room temperature to provide full-strength castings with mechanical properties equivalent to heat-treated alloys. Tenzaloy also has unusual dimensional stability, exceptional machinability, high impact and shock resistance, high yield and tensile strength, and excellent corrosion resistance.

Tenzaloy's unique inherent properties offer wide, new latitude to designers and manufacturers. For your copy of Bulletin 103R5, "Tenzaloy, the Self-Aging Aluminum Casting Alloy," write today to: Federated Metals Division, American Smelting and Refining Company, 120 Broadway, New York 5, N. Y.





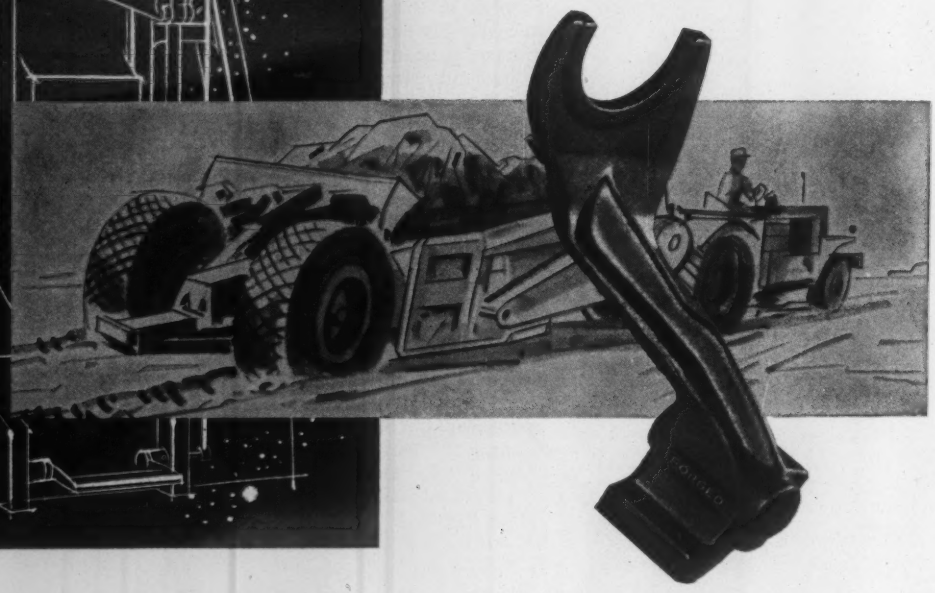
TENZALOY

ASARCO

For more information, turn to Reader Service card, circle No. 352

Modern board forging hammer

DEPENDABILITY of shifter fork improved by designing it to be FORGED



By designing the shifter fork of his transmission to be forged, a manufacturer of earthmovers eliminated costly equipment breakdowns in the field because of fork failure. Factor of safety was *in*creased even while weight and over-all costs were being *de*creased.

Parts scrapped because of voids uncovered after much high-cost machining are eliminated . . . forgings are *naturally* sound all the way through. Forgings start as *better* metal . . . are further *improved* by the compacting hammer-blows or high-pressure of the forging process.

Design your parts to be forged . . . increase strength/weight ratio, reduce as-assembled cost, improve performance. Literature to help you design, specify, and procure forged parts is available on request.

When it's a vital part, design it to be FORGED

Drop Forging Association • Cleveland 13, Ohio

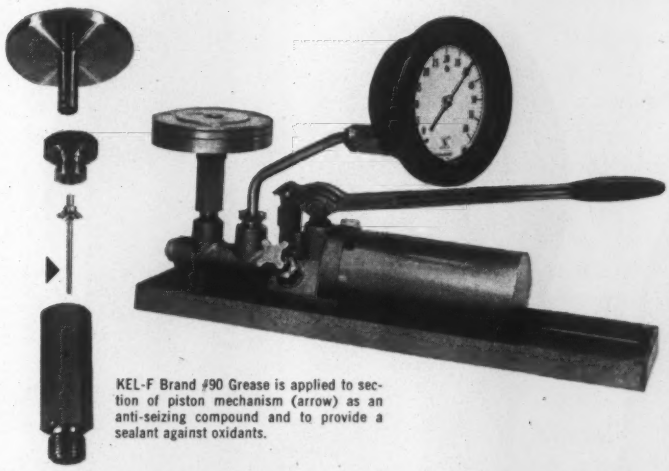
Names of sponsoring companies on request to this magazine

For more information, turn to Reader Service card, circle No. 327

3M COMPANY CHEMICALS

THE RAW MATERIALS OF PROGRESS

Dead weight tester's piston gets smooth glide with KEL-F® BRAND GREASE



KEL-F Brand #90 Grease is applied to section of piston mechanism (arrow) as an anti-seizing compound and to provide a sealant against oxidants.

Setting up standards by which pressure-measuring devices can be accurately checked and calibrated is the job of the Ashcroft Portable Dead Weight Tester above, a product of Manning, Maxwell and Moore, Inc., Stratford, Conn. KEL-F Brand #90 Grease provides lubrication for the tester's piston mechanism. The inert lubricant functions even when oxygen gauges are being tested; ordinary lubricants may explode in the presence of oxygen.

KEL-F #90 Grease helps ensure instrument accuracy within 1/10 of 1% because it does not become sticky, does not gum up, reduces piston maintenance and does not wash out with water which is frequently used as the testing fluid.

The dead weight tester utilizes interchangeable pistons for high and low-range pressures. Both of these pistons rely on KEL-F Brand Grease to serve as an anti-seizing compound.

#90 Grease is one of several KEL-F Brand Oils, Waxes and Greases intended for critical applications involving corrosive or reactive chemicals. See the "profile" column at right, then return coupon below.

Chemical Division, Dept. KAR-81
3M Company
St. Paul 6, Minn.

TELL ME MORE...
about KEL-F #90 Grease

Name_____

Title_____

Company_____

Address_____

City & State_____

PROPERTIES PROFILE on KEL-F BRAND OILS, WAXES AND GREASES

KEL-F Brand Oils, Waxes and Greases are a homologous high-density series of low-molecular weight chloro-fluorocarbon polymers. As lubricants, fluids and sealants, this series provides maximum resistance to oxidation, chemical attack and thermal breakdown.

RESIST CHEMICALS! Unaffected by alkalies, oxidants and acids, even hydrofluoric, fuming nitric and fuming sulphuric—also withstand hydrogen peroxide and aqua regia.

RESIST HEAT! Thermally stable up to 500°F., this series will not carbonize or support combustion—provides low thermal conductivity.

LUBRICITY. Excellent load-bearing and wear characteristics, equivalent to pure EP (extreme pressure) additive.

HIGH DIELECTRIC STRENGTH! This series exceeds 200 volts per mil in dielectric strength, resists thermal cycling and high humidity, is non-corrosive to metal.

OTHER PROPERTIES. Density may be up to twice the specific gravity of water. Oils are liquid at room temperature, with pour points as low as -80°F. Waxes are solid at room temperature, have a melting point of 100 to 190°F. Greases are compounded oil and wax products containing inert thickeners. They remain semi-solid in their normal operating range of 0 to 350°F.

WANT MORE INFORMATION? Just ask the nearby 3M Chemical Representative. He will provide complete data on KEL-F Oils, Waxes and Greases to help you solve critical application problems. Or write, stating area of interest, to 3M Chemical Division, Dept. KAR-81, St. Paul 6, Minn.

"KEL-F" is a reg. TM of 3M Co.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

For more information, turn to Reader Service card, circle No. 381

Custom Quality

OHIO COLD DRAWN

features improved physicals, closer tolerances, better finish

Arrows indicate approximate center of weld line. After normalizing, cold drawing and annealing, the weld area cannot be detected even when the polished and acid-etched surface is magnified 100 diameters. This perfect microstructure makes Ohio Drawn-Welded, in every sense, weldless — an ideal tubing for critical mechanical and pressure applications. In addition to cold drawing, a severe test in itself, non-destructive tests such as air, water, magnetic and eddy current, insure 100% acceptability.

A-4363

WELDED STEEL TUBING

Now Available in Larger Sizes... Heavier Wall Thicknesses

NEWS ITEM:

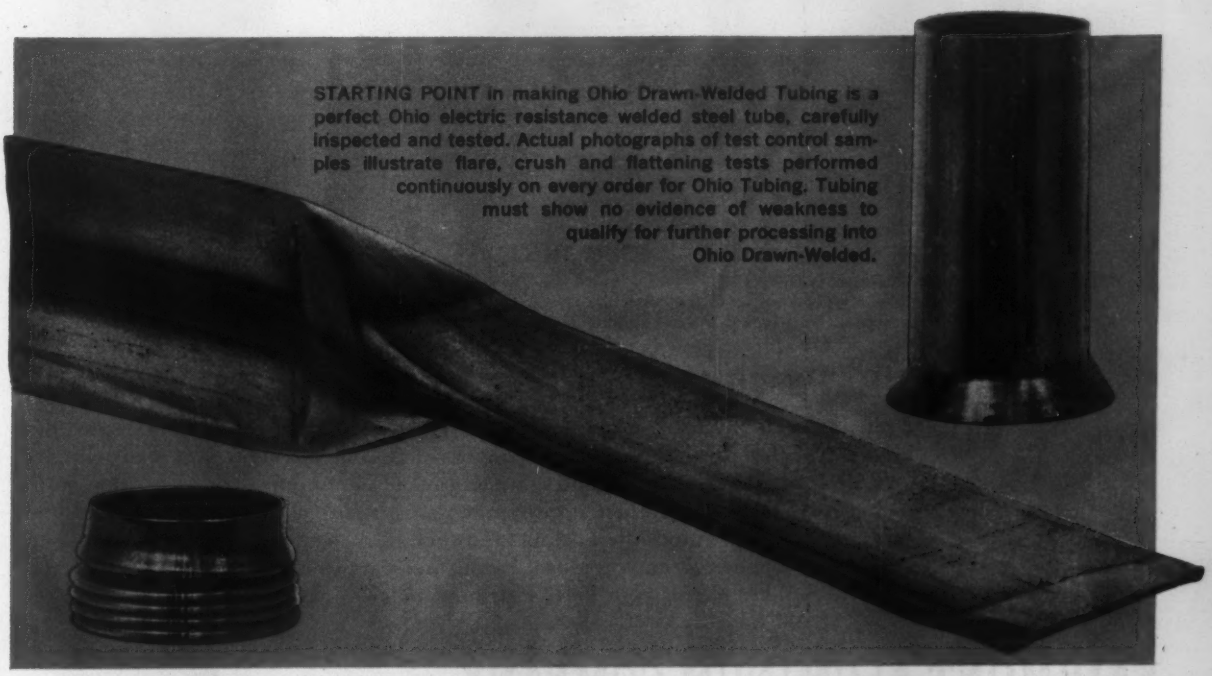
Ohio Seamless is now cold drawing quality electric resistance welded steel tubing up to 7¼ inches with wall thicknesses to .344. Ohio Custom Made Drawn-Welded Tubing is here now — in greater range of sizes, wall thicknesses, finishes than ever before.

TECHNICAL ITEM:

Controlled normalizing assures desired microstructure . . . Precision cold drawing imparts special physical properties, assures uniform wall thickness, delivers closer dimensional tolerances and superior surface finish.

ACTION ITEM:

This all adds up to a new major-source capability that can help you design with new freedom, manufacture at lower costs. Mark your orders: Ohio Custom Made Tubing. Either welded or seamless, it's your best buy whenever tubing is the best shape.



STARTING POINT in making Ohio Drawn-Welded Tubing is a perfect Ohio electric resistance welded steel tube, carefully inspected and tested. Actual photographs of test control samples illustrate flare, crush and flattening tests performed continuously on every order for Ohio Tubing. Tubing must show no evidence of weakness to qualify for further processing into Ohio Drawn-Welded.

For more information, turn to Reader Service card, circle No. 326

OHIO SEAMLESS TUBE

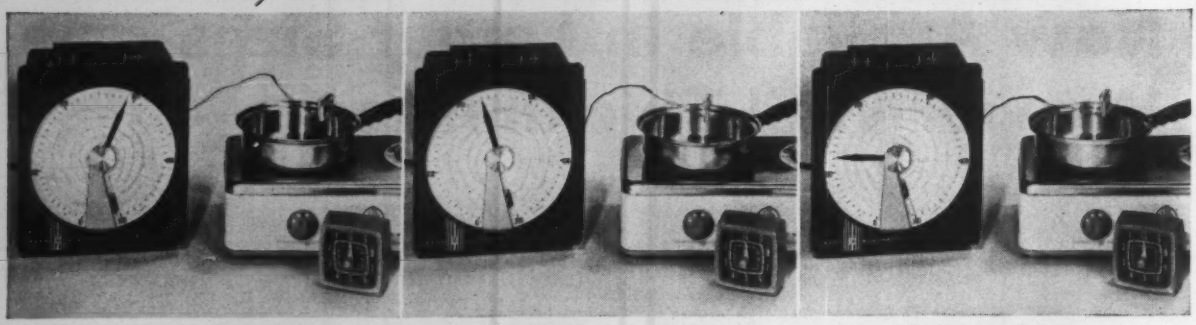
Division of Copperweld Steel Company • **SHELBY, OHIO**

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

Representatives in principal cities. Check leading directories:
THOMAS', MacRAE'S, CONOVER-MAST, SWEET'S, FRASER'S,

EVEN DOUBLE THE THICKNESS:

Fairmont Stainless Clad Aluminum sheet gives you FASTEST, MOST UNIFORM HEAT TRANSFER



Fairmont Stainless Clad Aluminum
.100 THICK

Copper Core Stainless
.050 THICK

Carbon Core Stainless
.050 THICK

After five minutes at maximum distance from controlled heat source, pan made of Fairmont Stainless Clad Aluminum, even though double thick, shows 290° F at side wall—in comparison with 230° F for copper core pan and 120° F for carbon core pan. Utensils furnished by courtesy of Vita Craft Manufacturing Company. The testing devices courtesy, Leeds & Northrup.

LIGHTEST WEIGHT, WITH STRENGTH

Fairmont Stainless Clad Aluminum
.100 THICK

Copper Core Stainless
.050 THICK

Carbon Core Stainless
.050 THICK

Although twice as thick and correspondingly strong, the Stainless Clad Aluminum pan weighs up to ⅓ less than the copper core or carbon core pans. This means lower shipping costs. Also, increased sales appeal to Mrs. Homemaker, who will simply love a sturdy pan that's nevertheless easy to lift.

WHAT'S YOUR NEED FOR THIS MAGIC METAL?

2 plus 2 equal 4. And Fairmont Stainless Clad Aluminum—with its unique combination of the strength and corrosion resistance of stainless steel permanently bonded to the light weight, good conductivity of aluminum—adds up to a bonanza in business-building product improvements. In many fields. From pots and pans to appliance and automotive trim, to architectural components. Whatever your line, the above has given you ideas. Let us help you with them. Write for further information. Or phone your local Fairmont office for a Fairmont field engineer.

FAIRMONT ALUMINUM COMPANY

SUBSIDIARY OF **CERRO CORPORATION**

Sales Offices in Principal Cities

FAIRMONT • WEST VIRGINIA

FAIRMONT 3010 • CABLE ADDRESS: FARMON

For more information, turn to Reader Service card, circle No. 415

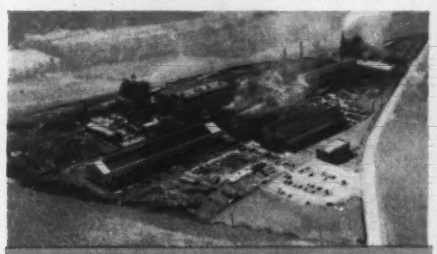
HAVE YOU EXPLORED

GLC

GRAPHITE

as a Problem-Solving Material ?

GRAPHITE PLANTS OF THE ELECTRODE DIVISION
GREAT LAKES CARBON CORPORATION

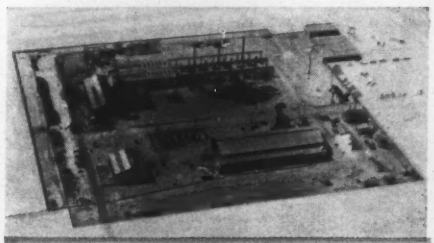


Morganton, North Carolina

Niagara Falls, New York

Are you looking for an economical substance that combines machineability, chemical inertness, high thermal conductivity, high temperature stability, and resistance to thermal shock?

Are you looking for a material that has proved to be highly suitable for such diverse applications as vital nuclear reactor components, molds and dies for metals casting, sintering boats and trays, run-out tables and canisters, refractories, brazing fixtures, linings in chemical process equipment, thermocouple shields, and electric resistance furnace parts?



Antelope Valley, Lancaster, California

ANGLO GREAT LAKES CORPORATION LIMITED
Affiliate of Great Lakes Carbon Corporation
Newburn Haugh—Newcastle upon Tyne, England

For an introduction to the excellence of GLC graphite—and to one of the world's outstanding graphite producers—write for a free copy of our illustrated brochure, "Graphite For Diversified Industrial Applications".

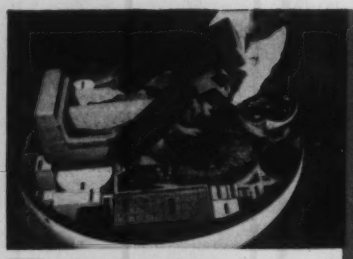
GREAT LAKES CARBON CORPORATION

PRODUCTS ELECTRODE GLC DIVISION YOU CAN TRUST ®

18 EAST 48TH STREET, NEW YORK 17, N.Y.
OFFICES IN PRINCIPAL CITIES

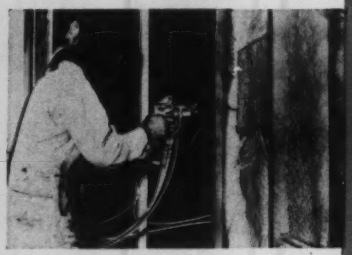
For more information, turn to Reader Service card, circle No. 408

1 USED FOR INSULATION, urethane foam has a K factor of .11 to .16.



2 AMERICA'S SPACE PROGRAM uses urethane cushioning, insulation.

3 MOLDED CHAIR, another "first" for urethane foam in furniture industry.



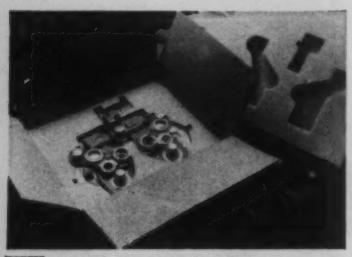
4 SPRAYED-IN-PLACE urethane foam insulation is quick, easy, efficient.

5 URETHANE INTERLINING gives warmth-without-weight in clothing.

6 FOAMED-IN-PLACE URETHANE insulates refrigerated trucks, reefers.

7 REUSEABLE FILTERS of urethane for air cleaners, air conditioners.

8 ACOUSTICAL TILE of decorative urethane foam for homes and offices.



9 CONTOUR-CUT urethane foam cushions delicate items in transit.

10 URETHANE CURTAIN WALLS go up fast, provide excellent insulation.

want to zero in on

knowledgeable information, experienced technical assistance and convenient source of supply

for URETHANE FOAMS?

FOR FAST ACTION . . .
indicate your main field of design interest by number in your inquiry.

MOBAY CHEMICAL COMPANY
Code MD-16 Pittsburgh 5, Pa.

MOBAY
First in Urethane Chemistry

BE SURE TO INCLUDE YOUR NAME & ADDRESS

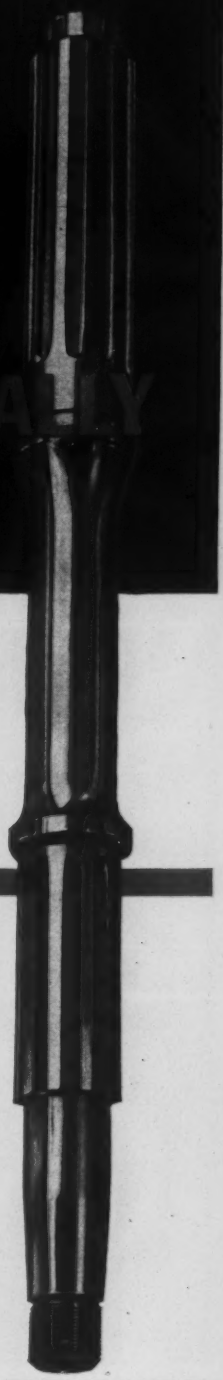
For more information, turn to Reader Service card, circle No. 418

Rockwell-Standard
changes from hot-rolled A-4140 to

fatigue-proof
STEEL BARS

elevated temperature drawing process **e.t.d.**

INCREASES PRODUCTION SUBSTANTIALLY — doubles tool life



Increases turning production 20%

Increases drill life 50%

Eliminates heat treating

Here's an example of how a small additional investment in material enabled Rockwell-Standard to increase production and cut cost on an axle for farm equipment.

Part: Axle for a self-propelled harvester.

Steel: FATIGUE-PROOF steel bars . . . replacing HR resulphurized A-4140.

Result: Heat treating eliminated. More uniform hardness across the section (302 Brinell) including small diameters. Hand straightening eliminated. Shaft runout in turning, reduced from an average of .015″ to .005″ in turning. Lower cost per part.

PRODUCTION INCREASES

Turning Operations: Speed increased approximately 45%. Tool life increased from 12 to 25 pieces per tip . . . tungsten carbide tips were used.

Drilling Operations: Drill life increased approximately 50% with FATIGUE-PROOF.

Milling Keyway: Entire lot of 550 pieces were run on one cutter . . . cutter formerly required sharpening after 300 pieces.

Hobbing Operations: Production increased approximately 60% . . . from 26 pieces per hour to 44.2 pieces per hour. Hob life doubled.

FATIGUE-PROOF steel bars offer all these cost cutting advantages.

No heat treating necessary—no quench cracks, warpage or other heat treating problems. Costly operations eliminated.

Exceptional Uniformity—from surface to center, end to end, bar to bar, size to size, and lot to lot.

Faster Machining—faster than annealed alloys; 50% to 100% faster than heat treated alloys.

La Salle STEEL CO.

1418 150th Street
Hammond, Indiana

Available from your Steel Service Center

Send for FATIGUE-PROOF bulletin entitled, "A New Material." 24 Pages. Do it today!

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

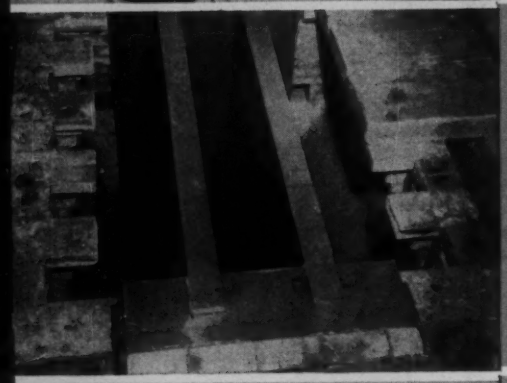
For more information, turn to Reader Service card, circle No. 433

Report from Carborundum:

How industry is solving unusual problems with unusual refractories

PACKING EXPANSION JOINTS:

CERAMIC FIBER WITHSTANDS 2300°F; EASILY PACKED; OBTAINABLE IN MANY FORMS. FIBERFRAX® ceramic fiber extends the temperature ceiling of fibrous insulating materials; opens new application areas. In rope or bulk form, it makes an excellent expansion-joint packing for refractory furnace walls. It is light in weight, highly resilient, does not shrink, is impervious to heat shock, and is inert to most furnace atmospheres. Various forms of FIBERFRAX — e.g. cloth, board, paper etc. — also offer advantages for gasketing, sealing, wrapping, lining, encapsulating, blanketing and jacketing.

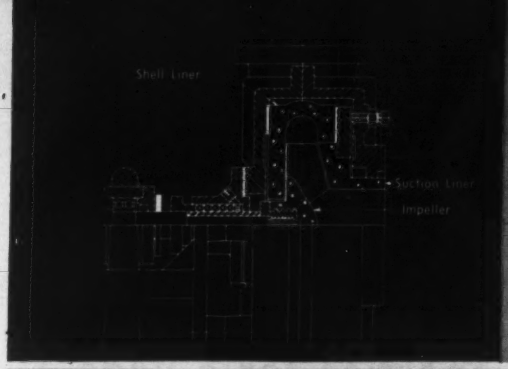


ZINC ORE REDUCTION IN VERTICAL RETORT:

RUGGED REFRACTORY WALLS CONDUCT HEAT FAST, STAY GAS TIGHT. Five million Btu's must be transferred through refractory walls such as shown at left for every ton of zinc produced. High heat conductivity — 11 times that of firebrick — is provided by CARBOFRAX® silicon carbide retort walls. Internal temperatures reach 2000°F. Other important refractory properties: great physical strength at high temperatures, chemical inertness, and unequalled abrasion and erosion resistance. Low permeability is also important because gas-vapor mixtures produced in the retort must be contained.

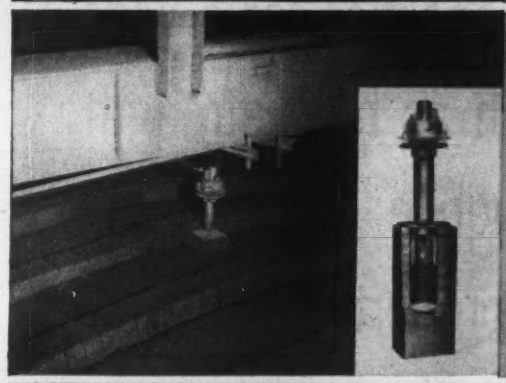
SPRAY NOZZLE FOR CORROSIVE SERVICE:

REFRACTORY REPLACES METALS—RESISTS HIGH TEMPERATURES, CORROSION, THERMAL SHOCK. The nozzle illustrated sprays a 15% solution of SO_2 in water at 150°F into a chamber operating at over 1700°F. Conditions involve severe thermal shock and corrosion. Previously used metal nozzles often lasted less than two months. Nozzles made of Carborundum's silicon carbide have shown no signs of failure after five years of service — another example of how these versatile refractories can take unusual forms to meet highly specialized problems.



PUMPING ABRASIVE SLURRIES:

REFRACTORY PARTS FOR PUMP RESIST WEAR, OUTLAST HARDEST METAL ALLOYS. Development of REFRAX®, a silicon-nitride-bonded silicon carbide, makes it possible to use refractories in many applications usually requiring metals. It can be formed with high dimensional accuracy as well as a high finish. Examples of use are impellers and shell liners in "Lightning" sand and gravel pumps made by Kansas City Hay Press Co. Comparative performance during a six months' test pumping 150 GPM of water with 20% silica sand against a 70-foot head has shown that REFRAX parts give more than five times the life of duplicate parts made of nickel chrome alloy.



MAKING 200 TONS OF STEEL BEHAVE:

TARGET BLOCK HELPS KEEP FURNACE TEMPERATURE AT MAXIMUM PRODUCTION LEVEL. The temperature detector shown in the open hearth roof at left is mounted in a hollow silicon carbide block. The detector is focused on a target disc made of another one of Carborundum's refractories — REFRAX refractory. Radiated heat from the disc provides a constant check on roof temperature . . . assures maximum production without danger of "losing" the roof. These two refractories provide the necessary properties of high heat conductivity, resistance to high temperatures and furnace gases and exceptional hot strength. Device is manufactured by Leeds & Northrup Co.

FIRING ELECTRICAL PORCELAINS:

SILICON CARBIDE KILN FURNITURE SIMPLIFIES CAR SETTINGS, PROTECTS WARE; IMPROVES HEAT CIRCULATION. Kiln car at left is loaded with electrical insulators supported by CARBOFRAX silicon carbide tile, posts and girders. Setting enables car to carry maximum load; may be rearranged as needed to suit different sizes of ware. CARBOFRAX furniture possesses high hot strength, resists deformation, reduces breakage losses — in trip after trip through the kiln. Furniture is also designed to permit uniform circulaton of heat through and around car for best ware firing conditions.

SINTER-PLANT DUST COLLECTOR:

REFRACTORY LINING LASTS YEARS IN SERVICE INVOLVING HIGH-VELOCITY GAS AND ABRASIVE PARTICLES. Superior resistance to entrained abrasive particles is shown by a lining made of a Carborundum-made refractory in this primary dust collector. Cone lined with Carborundum's material has handled more than 2,500,000 lbs of abrasive sinter dust in seven years. Ordinary brick in other parts of the same collector has worn back to the shell in only 5 months. Other wear-resistant applications for Carborundum's refractories are in duct linings, blast furnace downcomers, hydro cyclones, chutes, bins, feeder tables, gas scrubbers, nozzles and other related applications.

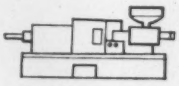
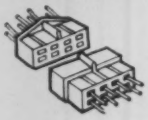
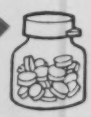
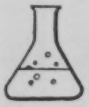
Want help on your problems?

Carborundum engineers will be glad to recommend refractories to answer your specific needs. For information, contact Dept. MD-81 Refractories Division, Carborundum Co., Perth Amboy, N. J. Descriptive brochures available on request. Please specify the area or areas of particular interest to you.

for engineered refractories . . . count on **CARBORUNDUM®**

For more information, turn to Reader Service card, circle No. 393

What's News In Plastics...

Escon® polypropylene offers molders  a balanced combination of properties for a wide range of molding applications such as high strength and impact resistance in automobile dash boards ...excellent electrical properties for cable connectors  ...high heat distortion temperature in vaporizers ...low water pick-up in distributor caps ... outstanding dynamic fatigue resistance for "living hinge" in accelerator pedals and snap-fit closures  for containers...outstanding chemical  resistance plus high gloss, surface hardness, and quality "feel" in dinnerware . All available for volume production at low cost.

The list of products made with Escon polypropylene is growing every day. Try this versatile molding material for your product. For full information write to Enjay, 15 West 51st Street, New York 19, N. Y.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY

For more information, turn to Reader Service card, circle No. 440

Bethlehem engineers redesigned these cost-saving specials.

Each of these special fasteners was redesigned to do a better job. And each represents a reduction in cost for the customer. Bethlehem's fastener engineers were able to come up with improved designs to solve a specific problem.

Perhaps a fastener you are now using should be studied to see if its redesign could cut your costs. Just send us a sample of the part, or a drawing or sketch of what you need. Maximum results will be obtained when you supply a detailed description of the end use.

Our fastener engineers will look it over and give you an honest appraisal of what can be done. Call the nearest Bethlehem sales office. Or write to us at the address below.

Steel

for Strength
. . . Economy
. . . Versatility

BETHLEHEM STEEL COMPANY, Bethlehem, Pa. Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

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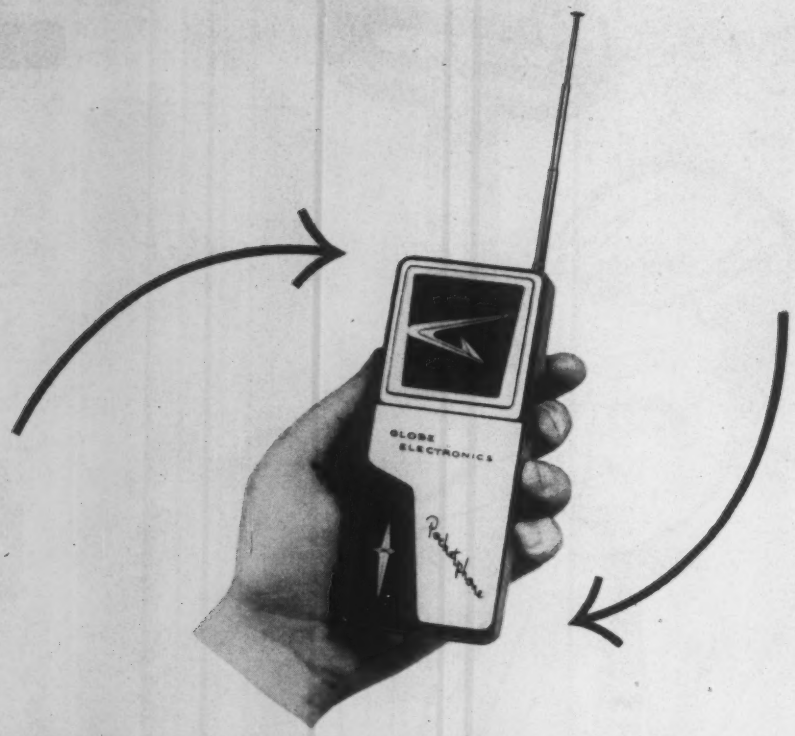

A jolt-taking, better looking case at a savings in cost

Globe electronics was faced with a challenge . . . perhaps you have a similar one right now. They wanted their new, tiny "Pocketphone" 2-way radio to have a modern case with eye appealing design and a rich lustrous finish. It had to be a thin walled material of high impact strength. And with all these was the important factor of cost.

Before specifying a standard plastic meeting one or two of the requirements, Globe design engineers consulted CMPC. Cycolac was the answer. Only it could meet all the needs—including cost—but only when CMPC know-how found the right way to use it. Now, this smallest 2-way radio's outside case, battery case and send-receive knob are custom molded by CMPC.

Why don't you bring your manufacturing challenges to the CMPC man . . . He'll have the right answer for you!

Send for new brochure "Design and Purchase of Custom Molded Plastics."

CMPC

CHICAGO MOLDED PRODUCTS CORPORATION
1020 F North Kolmar Avenue
Chicago 51, Illinois

For more information, turn to Reader Service card, circle No. 378

ALITE® Helps New Princeton-Pennsylvania Accelerator Unlock the Atom's Secrets

By accelerating protons around a ring 80-feet in diameter to velocities approaching the speed of light, smashing them into a platinum target to disintegrate some of its atomic nuclei and studying the particles that shower out, scientists at the Princeton-Pennsylvania Accelerator will be gaining new knowledge about nature's basic building blocks.

Because extreme tolerances must be met in order to maintain the necessary control of the protons, only components of the finest materials and most careful workmanship were acceptable for use in the new machine.

We're proud that we at Alite were selected to produce the high alumina ceramic spacers which support, position and insulate the magnet pole pieces in the Princeton-Pennsylvania Accelerator.

The Alite formulation used in fabricating the thousands of magnet spacers required is 98% pure aluminum oxide. Alite was selected because of its high dimensional stability—dimensional tolerances on these parts were specified to ±.0002 inches, or about the diameter of a human hair.

In supporting the pole pieces, which generate huge magnetic forces, the Alite spacers are expected to be subjected to unit loads as high as 40,000 psi.

If you need a material that is rugged . . . will withstand elevated temperatures . . . has superior resistance to corrosion, abrasion, thermal shock and nuclear radiation . . . that has exceptional dielectric properties . . . that can be metallized and brazed to metal parts to form a vacuum-tight seal—then perhaps Alite is your answer.

Tell us your specific requirements. Our ceramic specialists will provide all possible assistance.

446G

For detailed description and specifications of Alite, write for FREE Bulletins A-7R and A-40.

ALITE DIVISION

U. S. STONEWARE

BOX 119 ORRVILLE, OHIO

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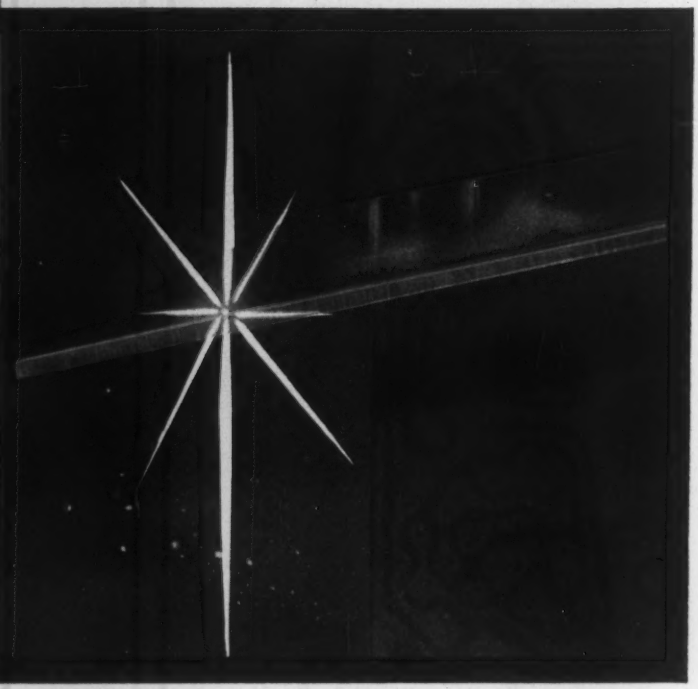
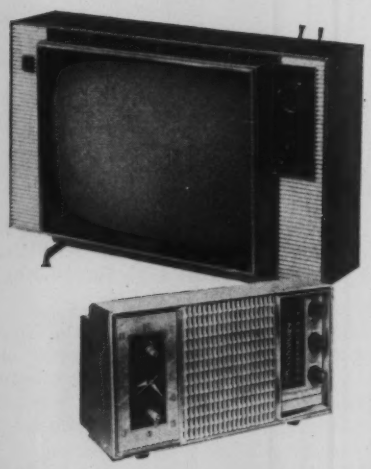
Textolite®/reliability

Textolite® 11571

RADIO and TELEVISION'S newest STAR





The General Electric TV Receiver Department is one of the major manufacturers of television sets sold in the United States. Contributing to this high volume has been the quality achieved through rigid manufacturing procedures. Part of the strict specifications call for Textolite 11571 XXX PC Copper-Clad laminate for use as circuit boards in all of their TV home receivers.

According to a TV Department spokesman, 11571 was selected because of its excellent insulation resistance under humid conditions. It has superior punching characteristics, stands up well in soldering and has good peel strength. Mr. W. W. Ward, Supervisor, Components, TV Receiver Department, said, "Since changing to 11571, production quality has been materially improved. It is the best laminate we've ever used."

Especially designed for use in television and radio receivers, G-E Textolite 11571 reliably meets UL testing standards, MIL-P 13949B and MIL-P 3115, type PBE-P specifications as well as NEMA XXX PC requirements. If you manufacture TV or radio equipment, you probably have an application in which 11571 would assure added reliability at a low cost. We will be happy to supply you complete information and samples. Write: Laminated Products Department, Section MD-81, General Electric Co., Coshocton, Ohio.

Wescon Show • Booth 4811

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information, turn to Reader Service card, circle No. 395

LASTING Eye Appeal
PLEXTONE®

multicolored textured finish for imaginative designers

In little more than a decade, Plextone has become an accepted industrial finish. Continuous research has resulted in new colors, new design effects, greater durability, wider application. Today, this textured, multicolored industrial finish has reduced costs up to 35 percent. Its one-coat application of two or more interlaced colors is sprayed at one time, from one gun! Shown above is just one of many pre-mixed Plextone colors available for prompt shipment.

For complete data and 1960 color card, mail the coupon today.

Leadership in finishes since 1876

MAAS & WALDSTEIN CO.

2114 McCARTER HIGHWAY, NEWARK 4, N. J.

Midwest Division: 1658 Carroll Avenue, Chicago 12, Ill.
Pacific Coast Division: SMITH-DAVIS CO., 10751 Venice Blvd., Los Angeles 34, Calif.

Maas & Waldstein Co.
2112 McCarter Highway, Newark 4, N. J.
Please rush color chips & complete data on new PLEXTONE.

Name_____
Title_____
Company_____
Street_____
City_____

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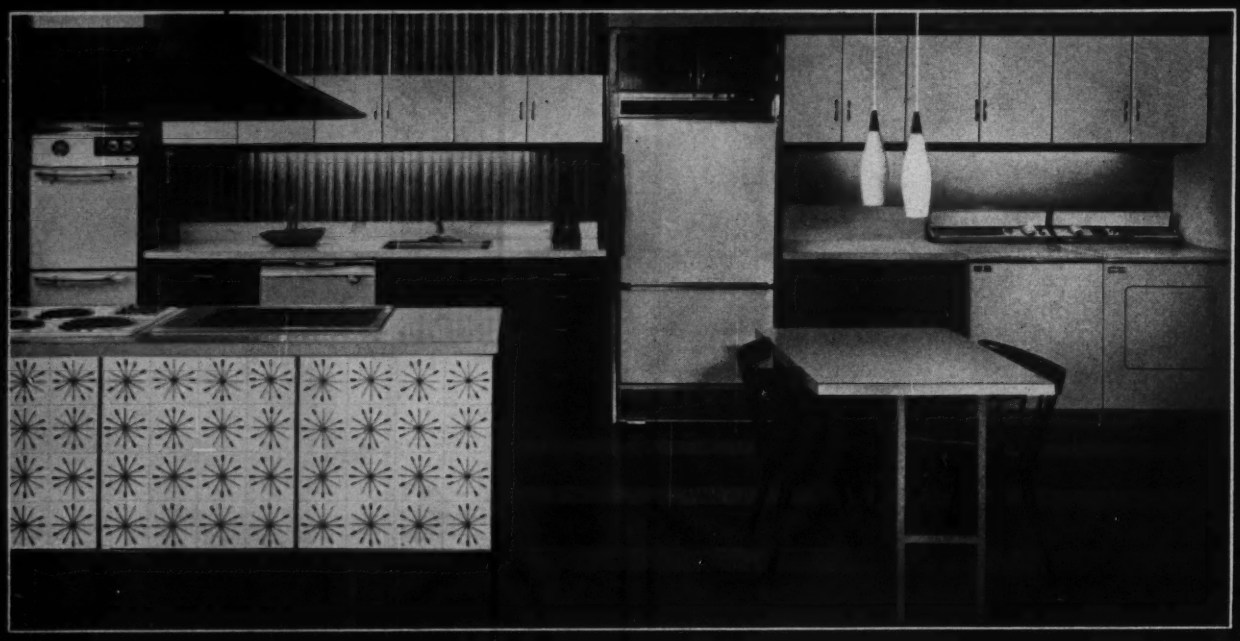

SEE HOW MANY MODERN THINGS THESE STEELS CAN DO FOR YOUR APPLIANCES

When you choose steel for your kitchen appliance line, yours is a product that's all things to all customers—whether they're quality-minded, budget-minded or beauty-minded. In fact, about the only thing that can equal steel's sales appeal is its advantage, economically, to you. Case in point: the modern steels of Weirton Steel Company.

TAKE WEIRKOTE®, FOR INSTANCE—and dispense with the extra costs of anti-corrosion coating operations. Weirkote galvanized steel offers you heavy-duty corrosion resistance, economical flake-free, peel-free fabrication and an advantageously low expansion-contraction rate. The latter gives Weirkote a vital edge over lighter metals—namely, an edge that stays put at the seams, despite the temperature changes that occur in stoves, freezers, refrigerators, washers and dryers. (Weirkote is also available from National Steel's Midwest Steel division.)

OR TAKE WEIRZIN®—an electrolytically zinc-coated steel with excellent corrosion resistance and, when chemically treated, superb paintability. These advantages, plus Weirzin's economical, flawless fabrication, make it an ideal choice for strong, durable, good looking kitchen cabinets.

OR WEIRTON COLD-ROLLED STEEL—to give you a fine, smooth finish and unexcelled ability to withstand the severe forming operations necessary for intricate designs.

OR PRE-PAINTED OR VINYL-COATED WEIRTON STEELS—Factory pre-painting of Weirkote and Weirzin or cold-rolled steel offers you built-in economy, controlled quality and any shade you might want. Vinyl coating, done by National Steel's Enamelstrip Division of Allentown, Pennsylvania, can be ordered in almost any texture and color. Any Weirton Steel goes through all production steps flawlessly and economically.

TAKE MODERN STEEL—particularly in any of the forms mentioned above. For full details, write Weirton Steel Company, Weirton, West Virginia.

WEIRTON STEEL
Weirton, West Virginia

A division of **NATIONAL STEEL CORPORATION**

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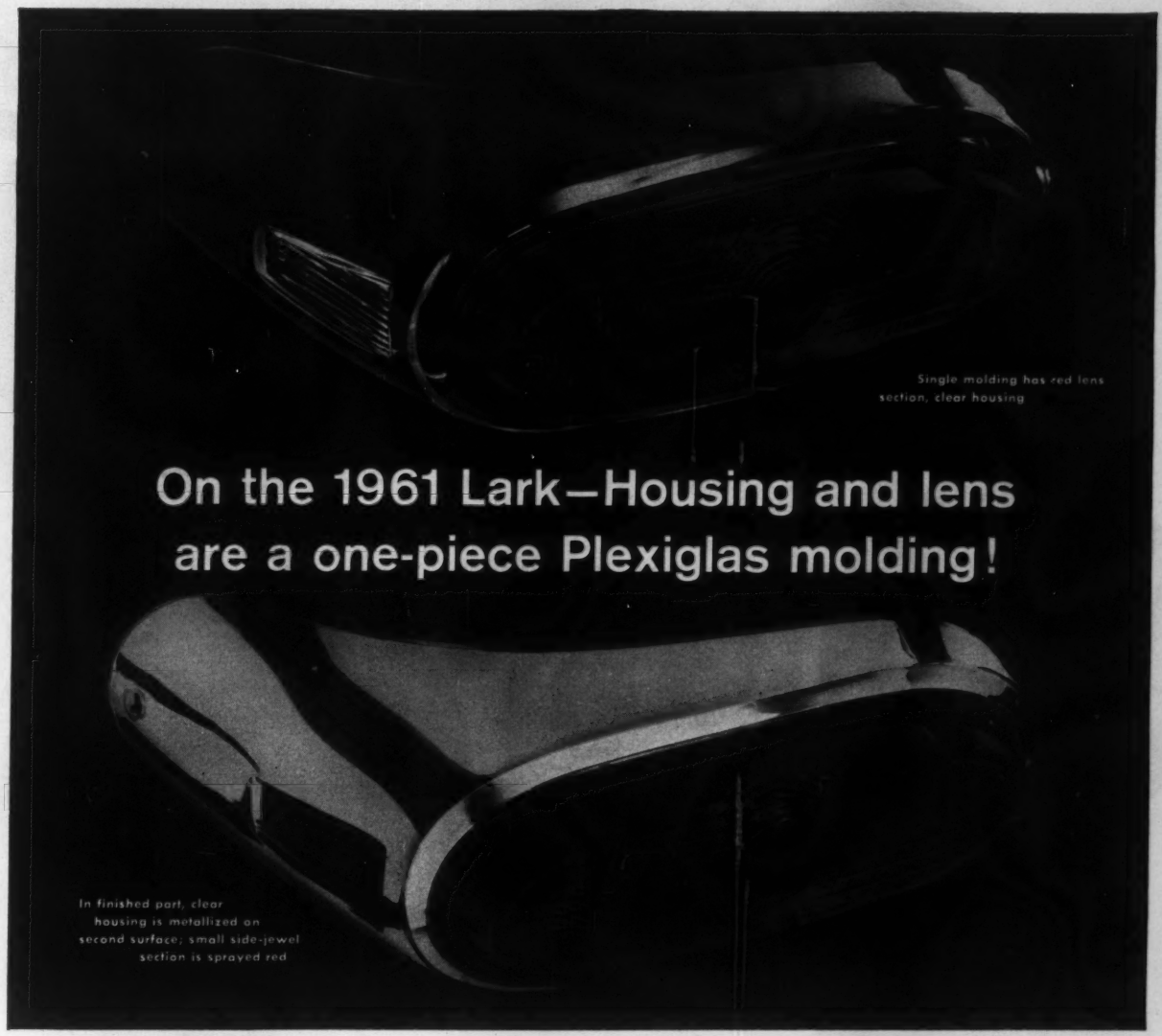
Single molding has red lens section, clear housing
On the 1961 Lark—Housing and lens are a one-piece Plexiglas molding!
In finished part, clear housing is metallized on second surface; small side-jewel section is sprayed red

The 1961 Studebaker Lark one-piece tail light "assembly" shown above is produced by double-molding red and crystal-clear PLEXIGLAS® acrylic plastic. The combined lens-and-housing is a first-time part in the automotive industry.

The advantages? An all-acrylic unit with handsome appearance, great strength and weather resistance, and a gleaming metallized section that stays bright . . . *at a cost reduction of approximately 30%* over the traditional assembly of lens, die-cast housing and gaskets.

There are many opportunities for obtaining improved performance at lower cost, in a wide range of products, by designing parts to be molded in PLEXIGLAS (and IMPLEX®, the high impact *acrylic*). We will be glad to send you information on these Rohm & Haas engineering materials.

ROHM & HAAS

PHILADELPHIA 5, PA.

Detroit Representative: *R. C. Oglesby, Nor-Way Building, 20211 Greenfield Road, BRoadway 3-0674.*

In Canada: *Rohm & Haas Company of Canada, Ltd., West Hill, Ontario.*

PLEXIGLAS

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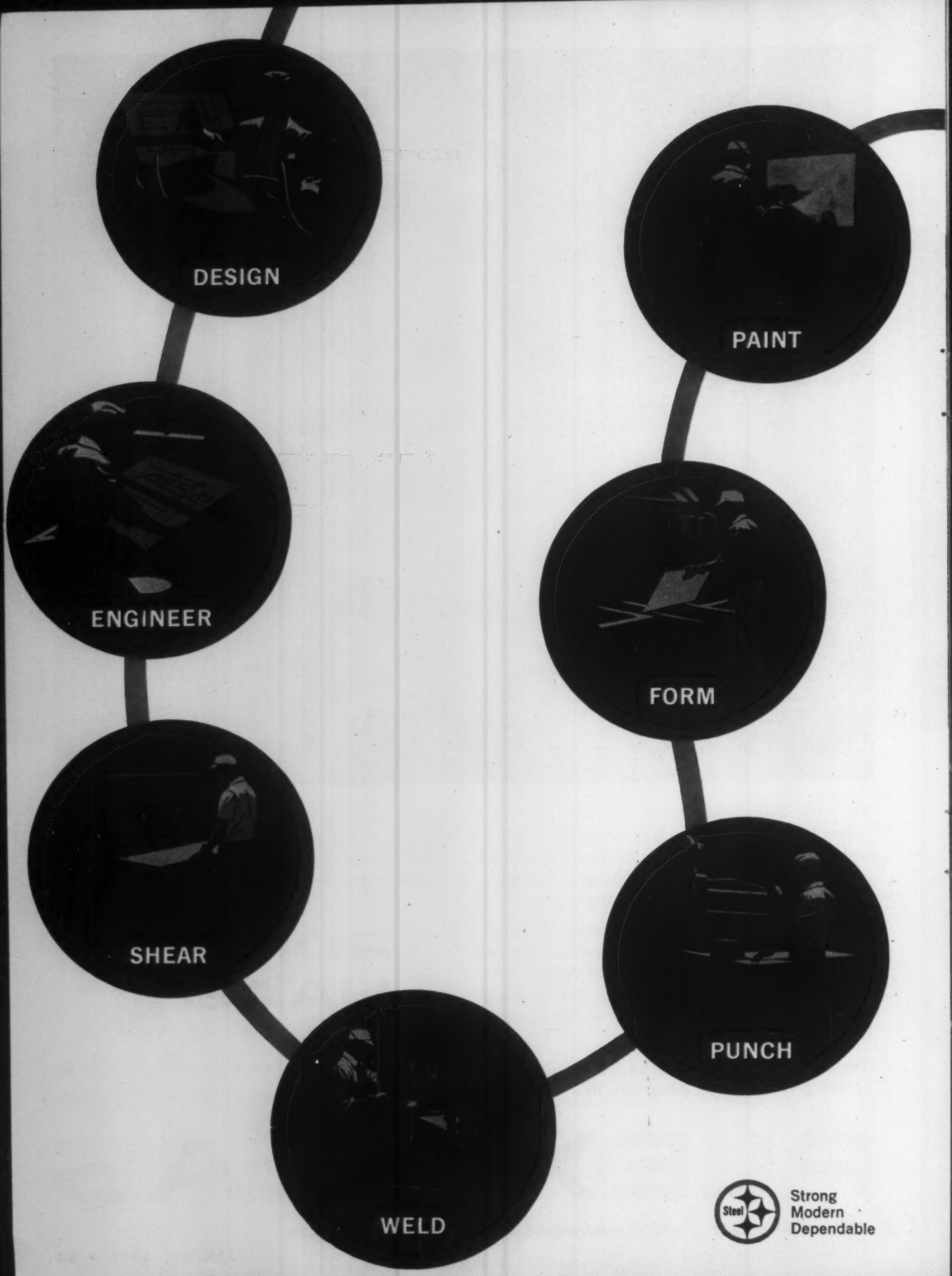
DESIGN
ENGINEER
SHEAR
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PUNCH
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Strong
Modern
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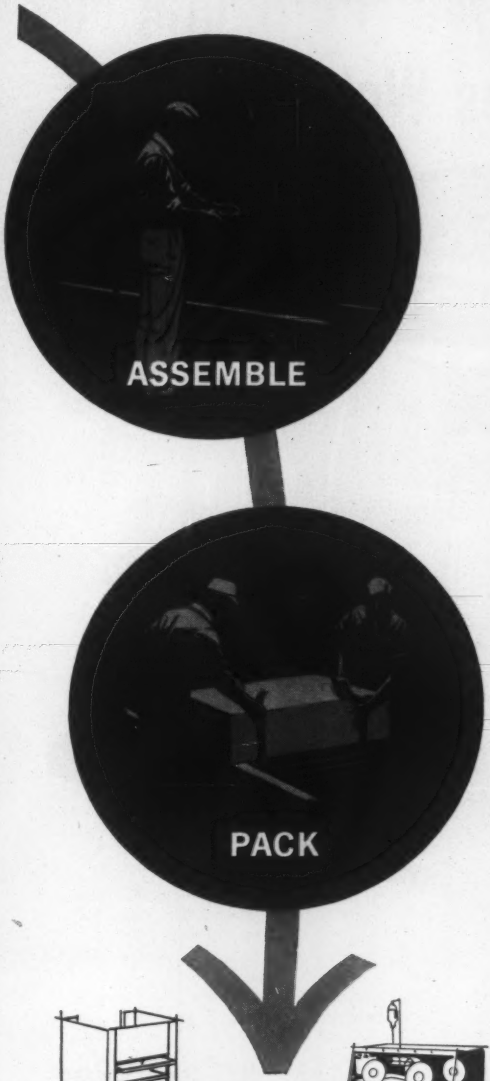
FROM DESIGN THROUGH FINISHED PRODUCT

Republic saves you money on sheet metal fabrication, every step of the way



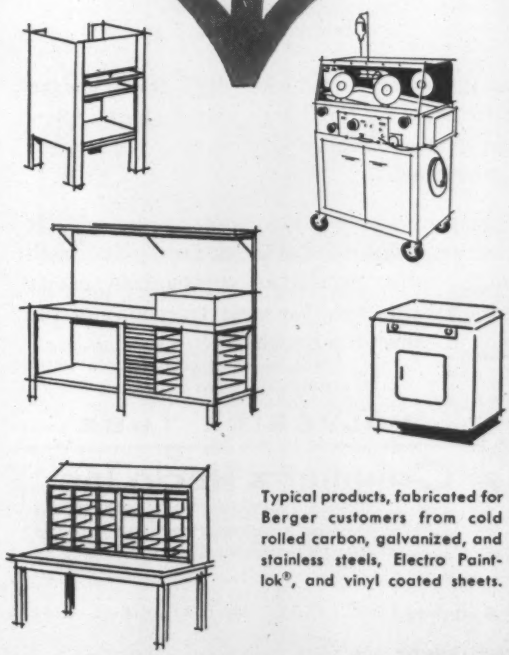
A skilled design and engineering staff . . . complete production facilities that include modern assembly lines for shearing, punching, forming, welding, Bonderizing, painting, and packaging . . . diversified experience and problem solving know-how backed by over 50 years of specialization in sheet metal fabricating . . . these are key reasons why Republic's Berger Division can save money, produce a better quality product, meet delivery schedules, *for you.*

A tour of Berger's efficient plant points up another factor that keeps costs at rock bottom. Scientifically planned material flow is combined with straight-through production lines to eliminate excessive handling, speed fabrication, assembly, and delivery.

Most important, you can put this $5,000,000 fabricating facility to work for you without investing a dime . . . to make cabinets, housings, and components for the products you now produce, or to make new items that will round out your line. For complete details, price quotations, and delivery information, contact Berger's Contract Manufacturing Department today, or mail the coupon below.

REPUBLIC STEEL

REPUBLIC HAS THE FEEL FOR MODERN STEEL



Typical products, fabricated for Berger customers from cold rolled carbon, galvanized, and stainless steels, Electro Paint-lok®, and vinyl coated sheets.

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REPUBLIC STEEL CORPORATION
BERGER DIVISION, DEPT. A-2350
1162 BELDEN AVE., CANTON 5, OHIO

Send more information on:
☐ Contract Facilities

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Company_____

Address_____

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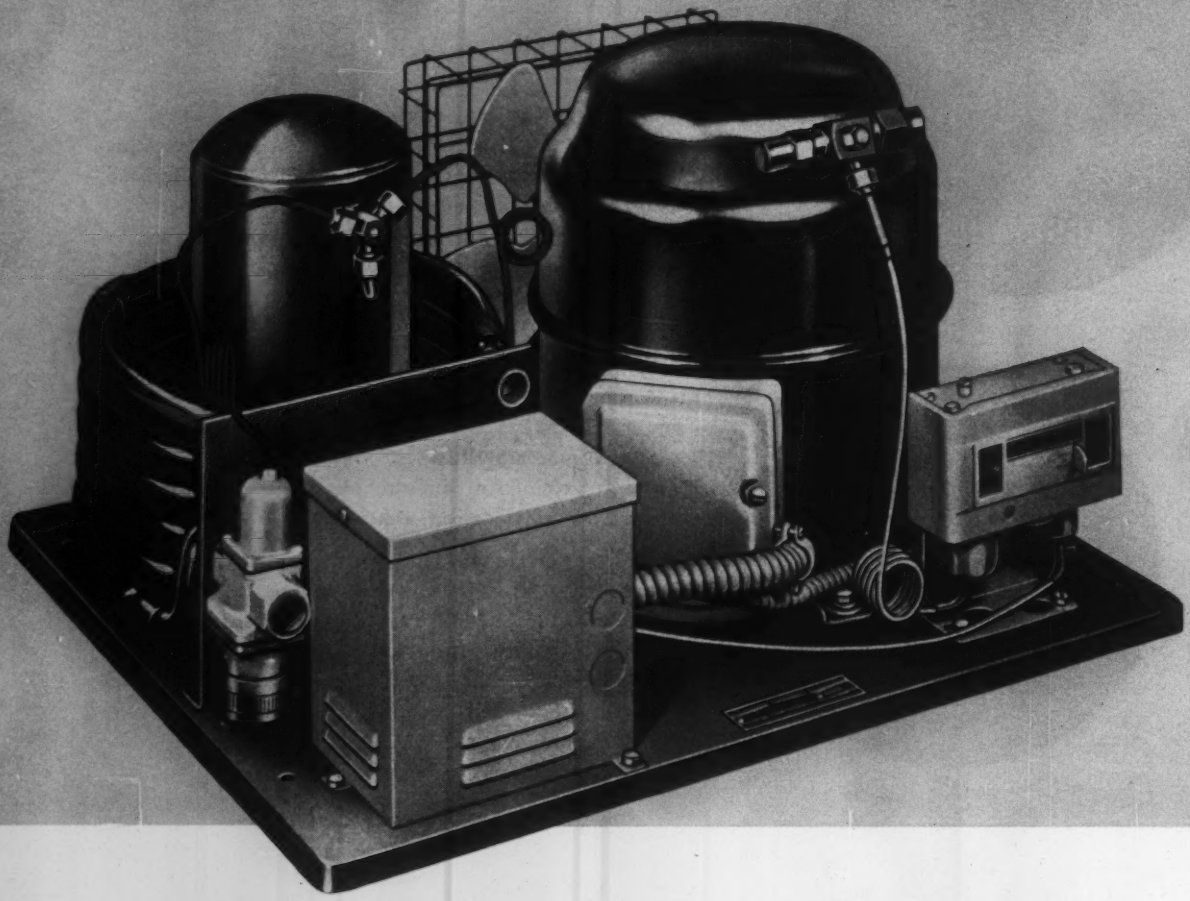
Tecumseh... Producer of Refrigeration Condensing Units... uses Wolverine Tube



WOLVERINE CAPILATOR®—the tiny, precision-made capillary tube for effective metering of liquids and gases – is an important contributor to the success of the hermetic condensing units manufactured by Tecumseh Products Company.

Tecumseh—one of the prominent producers of refrigeration compressors and condensing units uses Wolverine Capilator in its highside control system. Wolverine seamless copper tube is also used in suction and connecting lines.

So that it will meet the performance standards of Tecumseh and other American manufacturers, Capilator is always plug-drawn to insure smooth, mirror-bright inside diameters. Its ends are chamfered for unimpeded flow and, for maximum cleanliness, each length is washed in solvent, purged with "dry" air and has the ends paper wrapped. Capilator's manufacturing tolerances are rigidly controlled to meet customer's stated flow requirements.

If your company uses seamless copper, copper alloy or aluminum tube why not follow the lead set by Tecumseh and other leading American companies—specify Wolverine. Write, too, for your free copy of the Wolverine Tubemanship Booklet.

WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. P, 17258 SOUTHFIELD RD. ALLEN PARK, MICH.
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA • SALES OFFICES IN PRINCIPAL CITIES.

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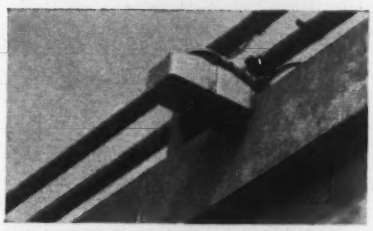
THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS FROM CORNING



ECHOES IN THE INFRARED TRIP A TRAFFIC SIGNAL

Your car passes under a compact little unit hanging over the road and—presto—up ahead a traffic signal changes to green.

There are two devices in the unit which is fabricated by Infrared Industries of Waltham, Mass. One emits a beam of infrared down at the pavement *via* a special glass lens which we supply. The second device receives the echo sent back when a car passes through the infrared beam. The beam bounces back up through another Corning lens, off a silvered reflector (also ours), and onto a cell which activates the unit. The unit in turn activates the traffic signal or just keeps track of the traffic.

If you happen to spot one of these devices on a drive and still have to stop for a red light, do not despair. Take those few seconds and consider the red, yellow, and green roundels on the traffic light itself. That's right, we make those too, and it's quite a trick, since we have to mass produce those roundels by the thousands, holding to some of the most rigorous color standards you've ever seen.

All of this adds up to a good story on the passing of light—visible or invisible—through glass. We have the capabilities. If you have the problems, perhaps we can get together and produce some products.

We'll be glad to send anything you ask for in the coupon.

A FEW FREE SUBSCRIPTIONS TO GLASS TALK STILL LEFT

Like many of our worlds, the world of glass continues to grow at a breathless pace . . . adding more and more exotic, but eminently useful, glass products every month.

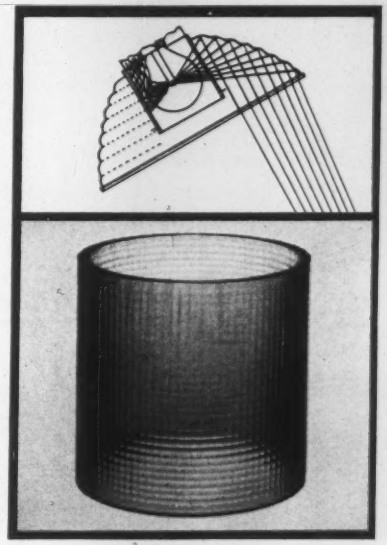
To keep people like you up to date on what's being done, we put out a bi-monthly (more or less) publication called *Glass Talk*. The economics of printing are such that we can add a number of new names to our mailing list without upping costs greatly.

So, if you think glass has a place in your future, send us your name and address on the coupon. Naturally, *Glass Talk* is *gratis*.

NEW BLUE AKLO® CYLINDER ABSORBS 99+% OF IR

If there's ever a man you want to keep comfortable, it's a surgeon. So, you take extra pains with his lighting.

You want to correct his light to daylight. You want both him and his patient to stay as cool as possible.



A new AKLO filter which we make does both. It takes 2900°K light from incandescent lamps and corrects it to 4000°K. It absorbs all but a niggling less than 1% of the lamp's infrared, hardly enough to raise the temperature of a flea.

Add this to a cylinder that has been designed to be used with clear lamps and you get smooth, reproducible results every time the unit is relamped.

Filtering like this recommends itself for lighting, for photoengraving and photography, theaters, movies, television—in short, any place where you have light- and heat-conscious customers.

Check the coupon, if you're interested.

GROUNDED GLASS

One of the old bugaboos of using glass in conjunction with extremely sensitive electronic devices—static charging—should bother you no longer.

We can supply a variety of shapes with an electroconductive coating which you can run to ground. And static charge drains off as soon as it forms, so there's no danger of outside signals throwing your device into a tizzy.

The same method also eliminates the nuisance noise broadcast by fluorescent tubes. We make a glass shield which looks like a regular lighting panel except that it, too, has a grounded electroconductive coating.

Think about this glass for a minute and you'll see there are many other equally sensible applications.

Run a current through a piece of it, for example, and you have a warm piece of glass . . . perfect for self-defrosting mirrors or windows.

You'll find that certain glasses become efficient infrared emitters when you run a current through an electroconductive coating . . . great for space heaters or driers (both of which we make).

Turn the glass around and cut off the current and you find that it *reflects* infrared while passing visible light. That makes an excellent heat shield.

Send the coupon for the full story on our electroconductive glasses.

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS, 5008 Crystal St., Corning, N.Y.

Please send more on:

☐ AKLO Filters ☐ IR-Transmitting Glass ☐ Electroconductive Glass
☐ Colored Lenses ☐ "Glass Talk"

Name..... Title.....

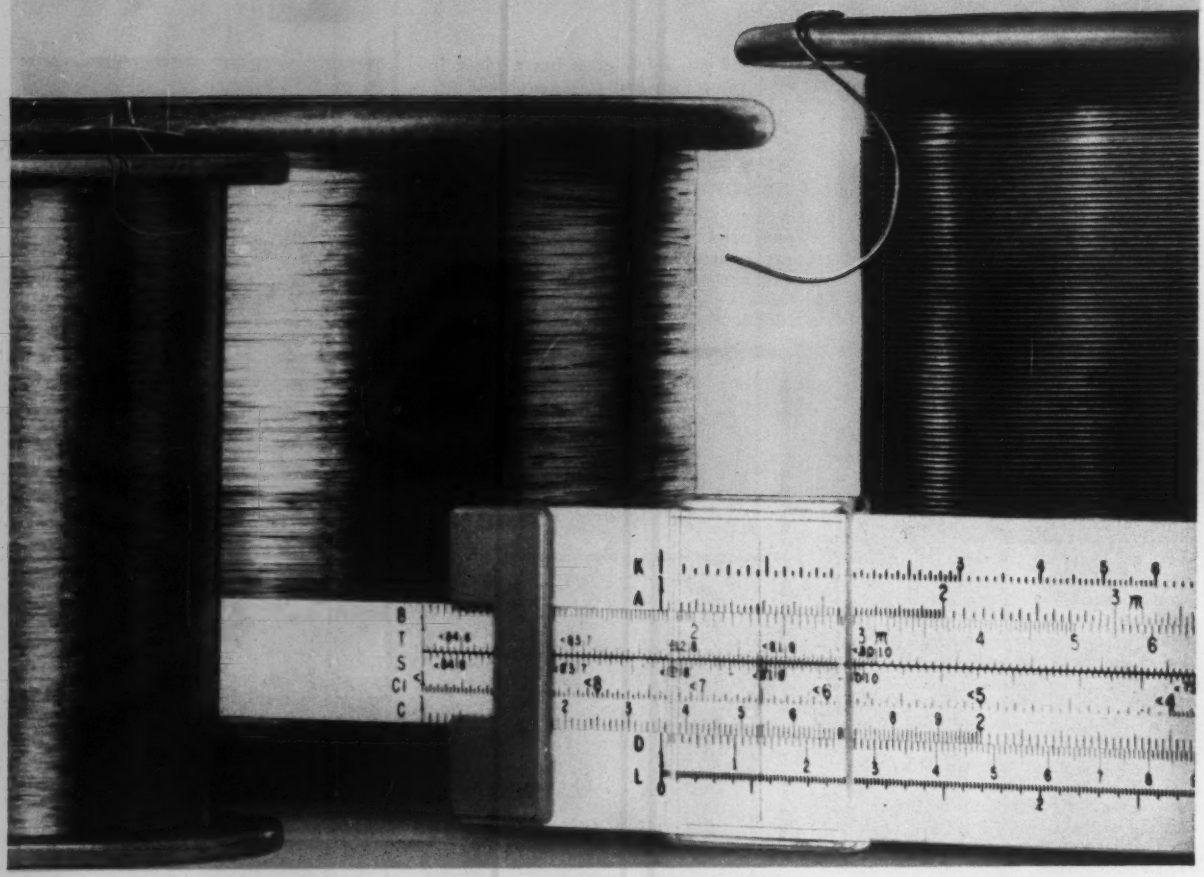
Company.....

Street.....

City..... Zone..... State.....

For more information, turn to Reader Service card, circle No. 353

SYLVANIA MAKES ALL THREE—ALLOY, CLAD AND PLATED WIRE



One way to conserve engineering time

—get an unbiased recommendation on wire from Sylvania

Rapid changes in high-temperature equipment plus the continued evolution in components mean this: it doesn't pay to get mired down by noncreative engineering details. Example: which wire to use to meet conductivity needs in corrosive or oxidizing atmospheres?

To make the most of your engineering time, call on *Sylvania* to help you with wire specs. Sylvania knows wire—and the particular advantages of each kind. Of all major manufacturers, only Sylvania makes all three types of bare wire—alloy, clad and plated. They're available in a complete range of sizes—.002" to .250". Each retains optimum characteristics up to recommended operating temperatures.

You know that a Sylvania recommendation will be objective, based on your needs, and not limited by what the supplier can supply. Full details—plus time saving help — are yours when you write Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

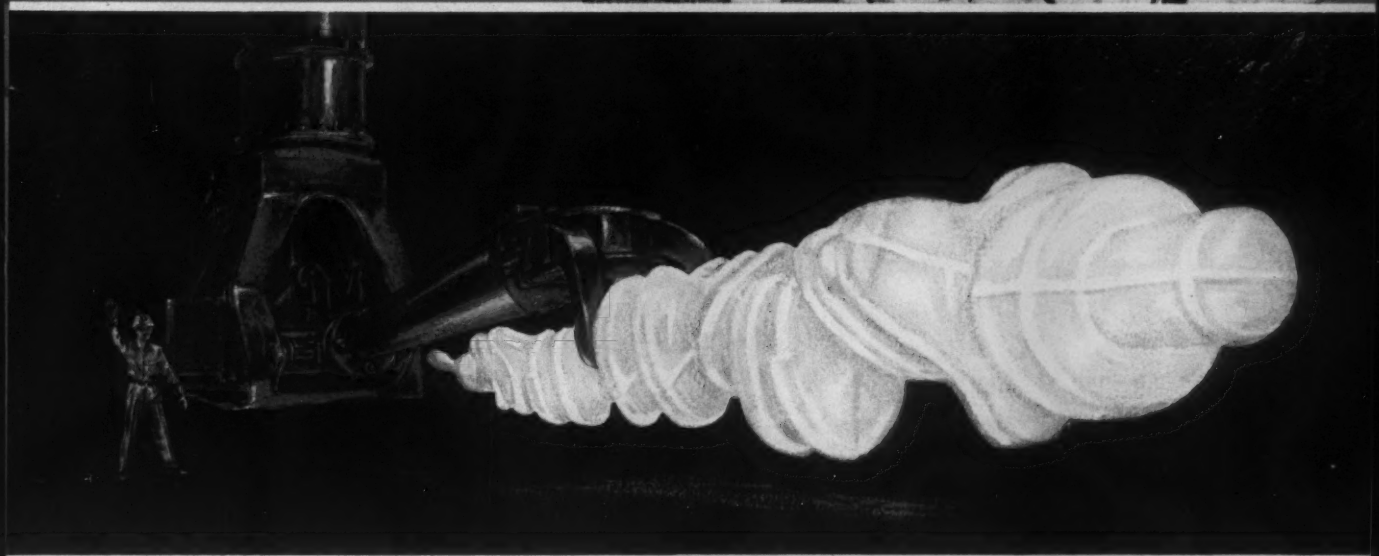
For more information, turn to Reader Service card, circle No. 377

NO MATTER IF DESIGNS WEIGH

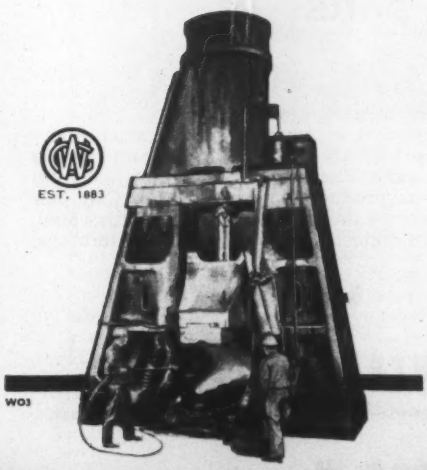
OUNCES

OR

TONS



. . . you always have the right supplier for any size forgings when you have Wyman-Gordon in mind



EST. 1883

W03

Little reason exists these days for permitting usual "design ceilings" on closed-die forgings—whether in weight, size or configuration—to handicap a product development program. For chances are Wyman-Gordon can lift such limitations entirely from any part planned, or now on your boards.

Your call will bring a seasoned forging specialist who talks forging language—in specific terms of design objectives—and has at his finger tips to help solve your problems the wealth of technical application and product-engineering data amassed by the country's foremost forging organization. Even more, he brings to your design team the latest developments in forging techniques and metallurgical breakthroughs that are substantially extending forging applications in every design dimension.

When you choose Wyman-Gordon you also benefit from the leader's experience in giving your parts optimum metal soundness and physical properties. While these are admittedly generalizations, they have been proven repeatedly in the products of hundreds of top-ranking industrial concerns we serve in every field. Our design assistance—on forgings weighing ounces or tons, produced from any forgeable metal or alloy—can prove as profitable for you as for them.

WYMAN-GORDON

FORGINGS

of Aluminum Magnesium Steel Titanium . . . and Beryllium Molybdenum Columbium and other uncommon materials

HARVEY ILLINOIS · WORCESTER MASSACHUSETTS · DETROIT MICHIGAN
GRAFTON MASSACHUSETTS · LOS ANGELES CALIFORNIA · PALO ALTO CALIFORNIA · FORT WORTH TEXAS

For more information, turn to Reader Service card, circle No. 401

Lexan resin provides dimensional stability in close-tolerance parts

Maximum change allowable in the overall dimensions of this five-inch attitude indicator component is only 5 mils over a temperature range of –65° to 300°F! Moreover, the aircraft instrument part must maintain these tolerances under conditions of high humidity. To meet these severe requirements for dimensional stability, Lear, Inc. selected LEXAN polycarbonate resin.

In addition to high performance, LEXAN offers easy and versatile fabrication. Thermoplastic, it is injection molded in half spheres which are joined by solvent cementing. After lathe turning to insure complete accuracy, the spheres are painted three different colors. Maximum visibility is obtained by lighting from the inside. With their high temperature resistance and high impact strength, these polycarbonate spheres are both rugged and precise design elements. They are fabricated for the Instrument Division of Lear, Inc. by Monroe Industries — both of Grand Rapids, Mich.

This component is an example of what high-performance LEXAN polycarbonate resin can do for your designs. The price of the resin has gone down, too, as production has gone up. Can *you* afford to overlook the major advantages of this new, major design material? Send for design literature.

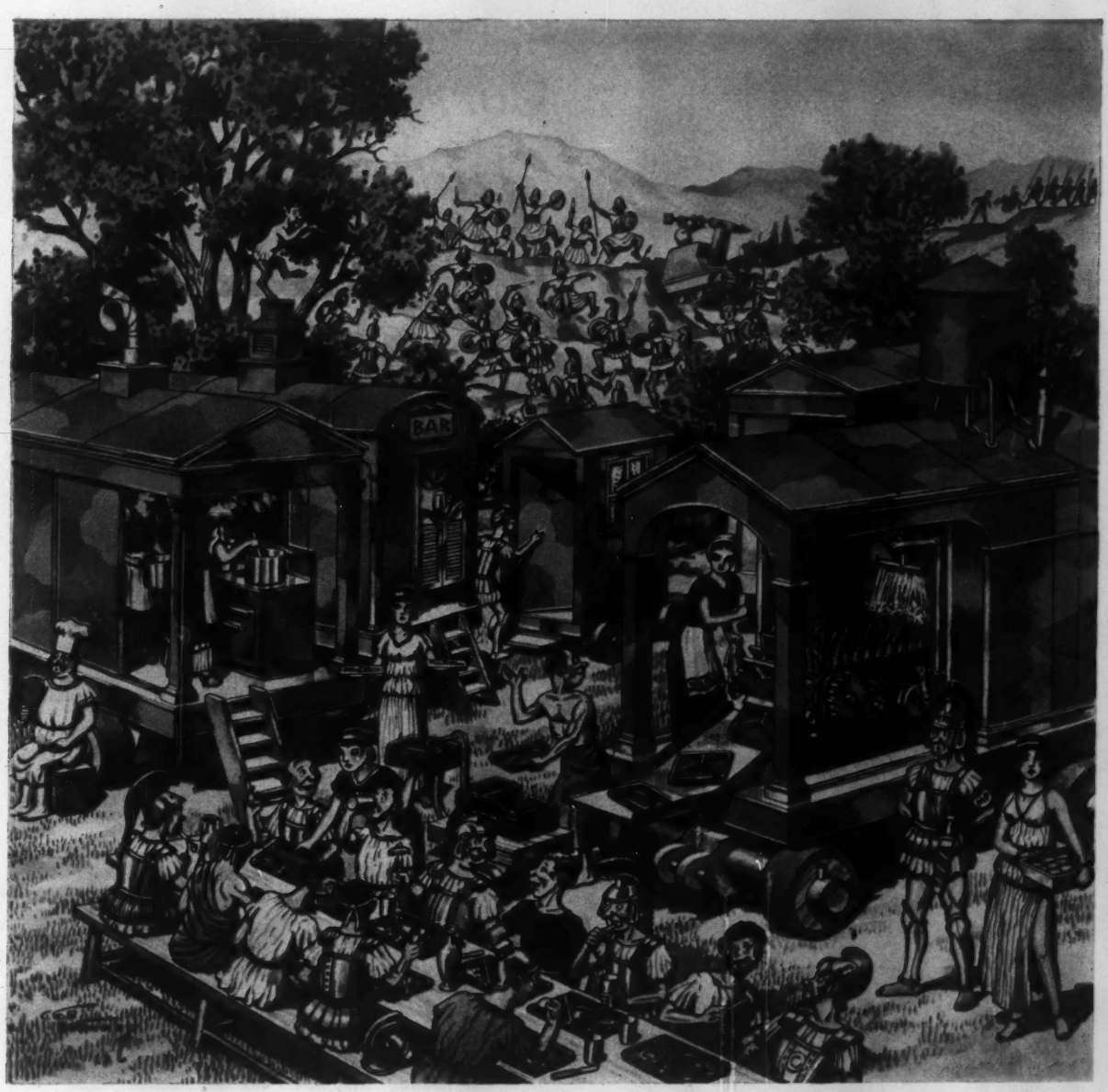
LEXAN®
Polycarbonate Resin
GENERAL ELECTRIC
Chemical Materials Dept., Section M-81, Pittsfield, Mass.

For more information, turn to Reader Service card, circle No. 428

Why Alexander's Army was Battle-Hungry

Alexander-the-Great was the top military leader of all time for a good non-military reason. He perceived that an army "travels on its stomach" so he provided stainless steel mobile kitchens for the sake of good taste. His soldiers literally "fought to eat."

Cleverly he used Washington Steel's ColorRold Stainless to camouflage the units—keeping his great secret weapon wholly unknown to the world until the accompanying sketch was unearthed recently from the grave of an early mess sergeant.



To be assured of good taste, always insist on stainless steel in food service equipment. Washington Steel's ColorRold Stainless enables you to enhance the beauty of your quality product—whether you are building a skyscraper, a space vehicle or a soup tureen. Go First Class, Go Stainless!

WASHINGTON STEEL CORPORATION

PRODUCERS OF *MicroRold*® and *ColorRold*® STAINLESS SHEET & STRIP

WASHINGTON, PA.

For more information, turn to Reader Service card, circle No. 441

Corrosion from Oxidizing Chemicals?

...Test **HAYNES** Alloys

Even in such violently corrosive oxidizing agents as ferric chloride—at concentrations boosted to 40 per cent and temperatures as high as 140 deg. F.—HASTELLOY alloy C figuratively snaps its fingers. At room temperature, its reaction is nil!

Alloy C and other HAYNES alloys resist most of the common oxidizing chemicals. Alloy C also resists strongly oxidizing salts such as cupric chloride, ferric and cupric sulphate, and chromates and nitrates in sulphuric and hydrochloric acids.

If oxidizing chemicals are a problem, you'll almost surely find the remedy among HAYNES alloys. There are nine HAYNES alloys developed over a 30 year span of intensive concentration on corrosion problems and the metals that best resist them.

Send for test samples . . . by sending us a letter outlining your corrosion problem. We will send you test samples of the HAYNES alloy best suited to resist it. Be sure to ask for a booklet on HASTELLOY alloys. Address us at 270 Park Avenue, New York 17, N. Y.

HAYNES
ALLOYS
HAYNES STELLITE COMPANY

Division of
Union Carbide Corporation
Kokomo, Indiana

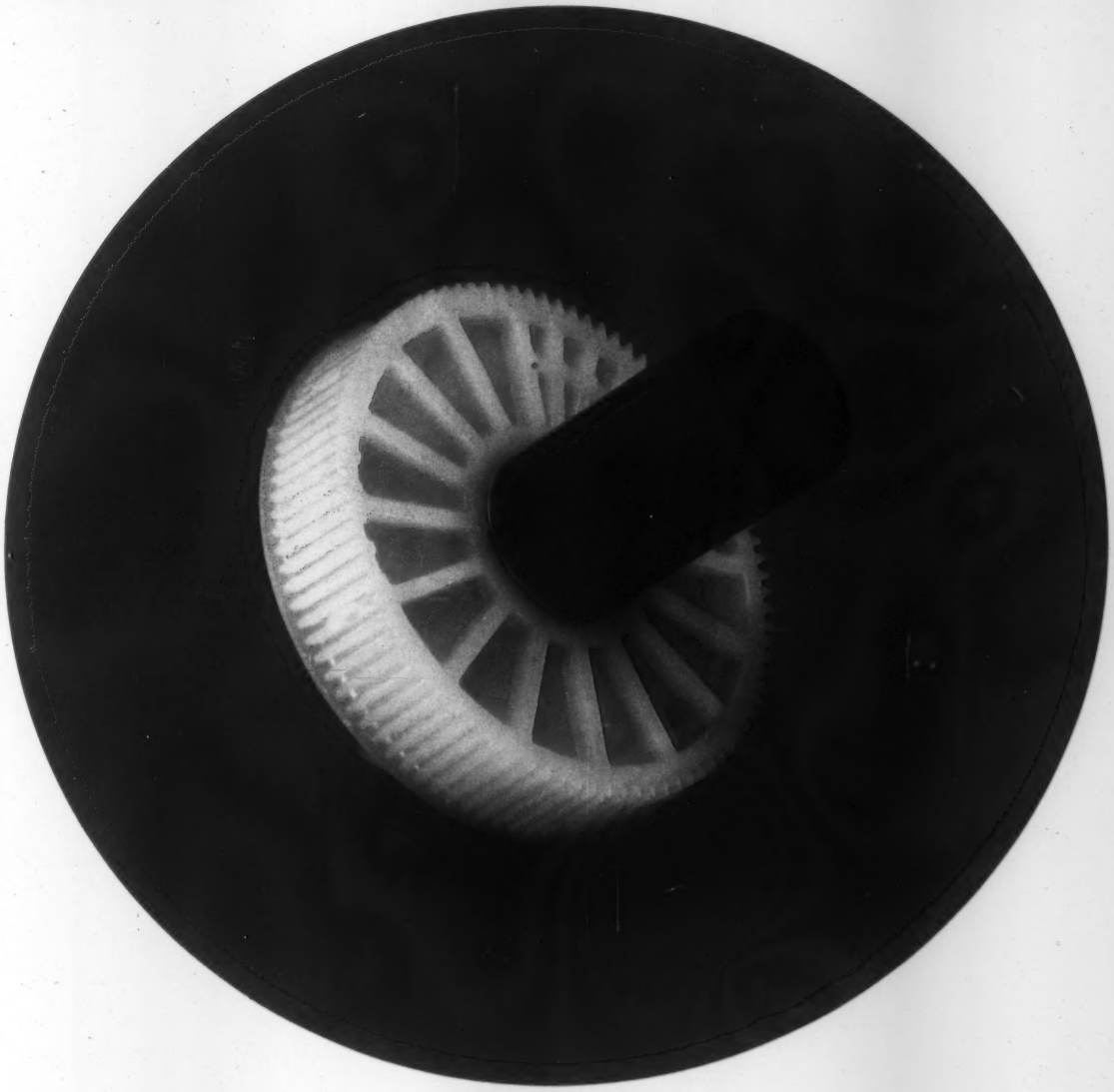
UNION CARBIDE

"Haynes," "Hastelloy," and "Union Carbide" are registered trade marks of Union Carbide Corporation.

For more information, circle No. 421 ➤

For more information, turn to Reader Service card, circle No. 390

PLASKON NYLON 6..LIGHT WEIGHT, HIGH IMPACT STRENGTH!



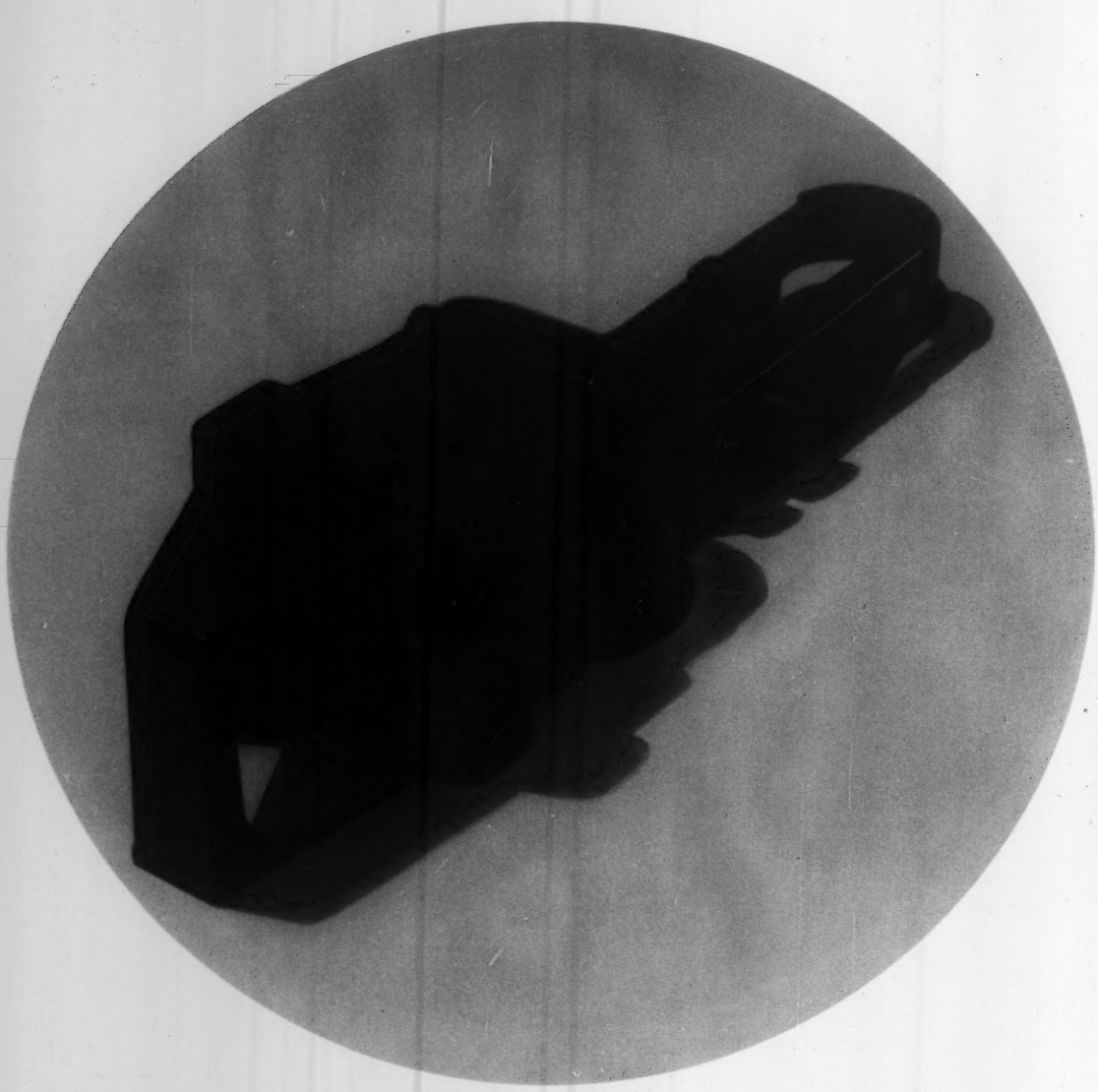
This windshield wiper gear must turn thousands of times without lubrication . . . resist heat and abrasion . . . withstand extreme changes of climate. It comes through with flying colors — because it's molded of Plaskon® Nylon 6.

Plaskon Nylon molding and extrusion compounds offer all the well-known nylon properties: toughness, light weight, high impact and tensile strength, resistance to abrasion, corrosion and heat. But they also add several advantages all their own: better dimensional stability due to lower shrinkage, fewer voids during molding, greater impact strength. Plaskon Nylon can be molded in thin (up to .030″) transparent sections, takes color easily before or after molding, and molds at lower cylinder temperatures. Write us for full technical data.

PLASTICS DIVISION
40 Rector Street, New York 6, N. Y.

Allied Chemical
BASIC TO AMERICA'S PROGRESS

Plaskon® POLYESTER RESINS SPEED PRE-MIX MOLDING



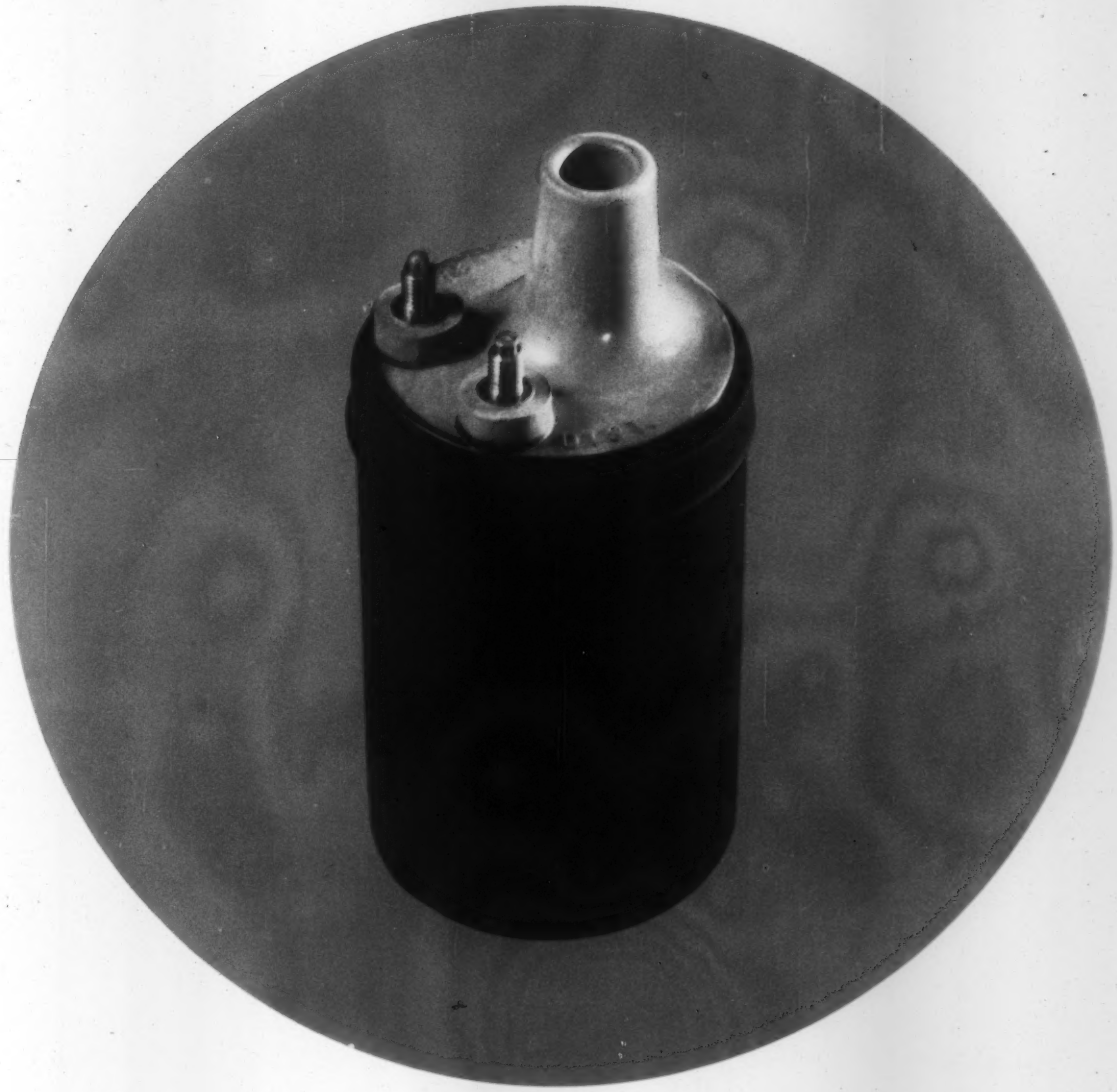
Rapid molding of parts (such as this automobile heater housing, as well as others with varying thicknesses and intricate contours) is facilitated by Plaskon® Polyester Resins for pre-mix molding. Ease of molding and excellent resistance to heat and common solvents, add to the usefulness of these hard-working materials.

Plaskon Polyester Resins were the first to be specifically designed so that molders could use their own glass or other reinforcements, fillers and catalysts in compounding molding materials. The pre-mix method offers fast-molding cycles at considerably lower cost than conventional preform or mat-molding of reinforced polyester resin laminates. Write for technical data.

PLASTICS DIVISION
40 Rector Street, New York 6, N. Y.

Allied Chemical
BASIC TO AMERICA'S PROGRESS

Plaskon ALKYD MOLDING COMPOUNDS RESIST FAILURE AT ELEVATED TEMPERATURES



Higher compression ratios, 12-volt electrical systems, added to the auto industry's increasing need for reliability and longer service life, all indicate the need for an insulating material of the quality of Plaskon Alkyd Molding Compounds for ignition coil towers.

Plaskon Alkyds resist arc-over better than any other thermosetting material. They provide higher dielectric strength and maintain dimensional stability at extremes of heat and cold, moist and dry temperatures encountered in the engine area. Alkyds provide trouble-free service longer.

Write for specific performance characteristics. Competent Plaskon representatives will be glad to discuss part design, material recommendation and molding procedures for your performance requirements.

PLASTICS DIVISION
40 Rector Street, New York 6, N. Y.

Allied Chemical
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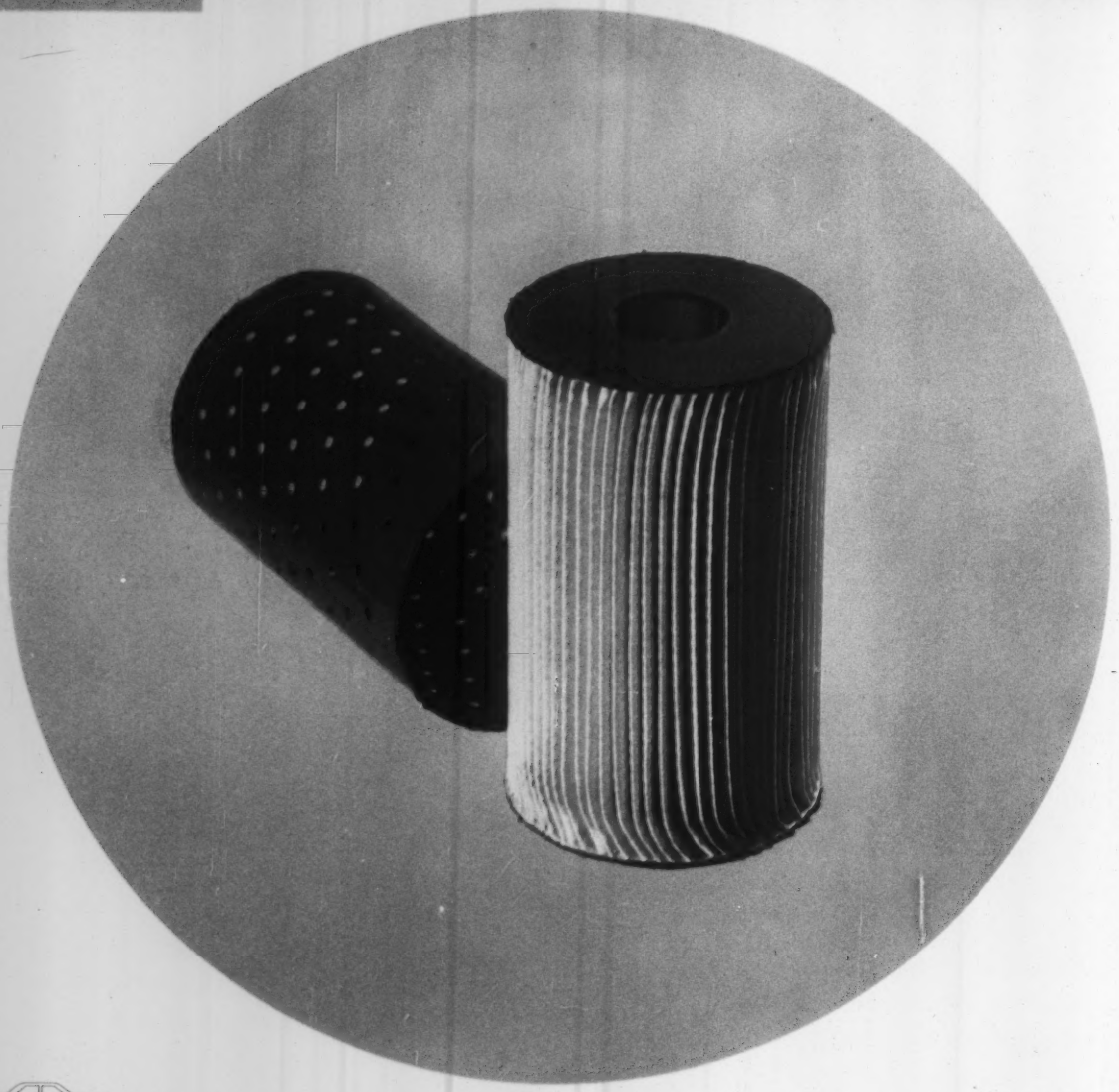
Plaskon PHENOLIC RESINS PRESERVE WET STRENGTH



Impregnation with Plaskon® Phenolic Resins increases the wet and heat strength of this oil filter cartridge — making it possible for the paper liner to withstand a continuous flow of oil as it filters corrosive impurities.

Water, alcohol, oils, greases, mild acids and common solvents do not adversely affect Plaskon Phenolics. These versatile materials have excellent heat resistance (up to 600°F when laminated with glass cloth). They undergo no marked change at freezing temperatures. Where extreme chemical resistance is required, special grades are available.

Excellent electrical properties have resulted in the wide use of Plaskon Phenolic Resins in battery separators, as well as other bonded paper and fiber products. If you are looking for toughness, dimensional stability and good resistance to heat, water and wear, write us for full performance data on Plaskon Phenolic Resins.

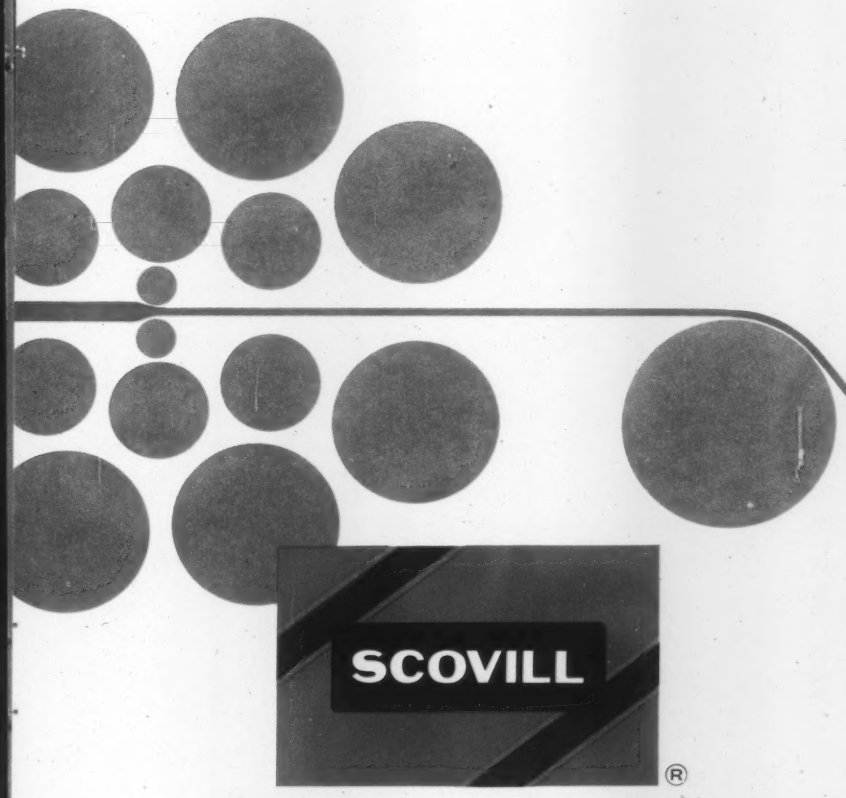
PLASTICS DIVISION
40 Rector Street, New York 6, N. Y.

Allied Chemical
BASIC TO AMERICA'S PROGRESS

the bargain basement . . . no place for bargains. It isn't often that a buyer finds more than his money's worth where every effort has been made to give him just a little less. The bargain basement is always downstairs . . . usually in more ways than one.

Keep this in mind the next time you are offered an opportunity to cut the manufacturing cost of one of your products by a "step down" to a substitute material. There is little to be gained, for example, by a switch from brass to simulated brass when a better Scovill Alloy . . . and a better application of it . . . may give you a real bargain in cost-savings rather than a precarious excursion into "cheaper" goods.

Why not talk it over with your Scovill Representative . . . he knows the fabricators' problems and he's helping many to find long-term solutions to them.



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MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

brass
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modern metals made better to bring out the BEST *in your products*

Scovill Manufacturing Company, Mill Products Division, 99 Mill St., Waterbury 20, Conn. Phone PLaza 4-1171

12SC61

PRODUCT BY ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

PROCESSING BY NSE

PRE-PAINT PROTECTION BY

AMCHEM **ALODINE***

This gleaming hangar facility of Scandinavian Airlines System at N.Y. International Airport features a tough, baked enamel Alumalure finish over strong, lightweight aluminum—Alodine treated for additional corrosion resistance and paint longevity.

For more information, circle No. 426

How Amchem Pre-Paint Treatment, NSE Processing Help Put the "Lure" in Alcoa Alumalure!**

Alcoa Alumalure baked enamel finish on industrial roofing and siding sheet has made a startling impact in building circles. A low cost, decorative, maintenance-free exterior wall surface, available in 11 colors, it is widely used for new buildings as well as remodeling older structures.

Key to Alumalure success—strong, light aluminum and design innovations by Alcoa . . . precision finishing by NSE Signs & Stampings . . . unmatched protection and paint adhesion by Amchem Alodine chemicals.

With color matching standards a prime-requisite, assurance of paint adhesion on Alumalure sheets is a vital necessity to protect customers who buy the product, months later reorder and expect exact color match. Results to date on millions of square feet of Alumalure processed—no paint failure or rejects involving chemical treatment by Alodine!

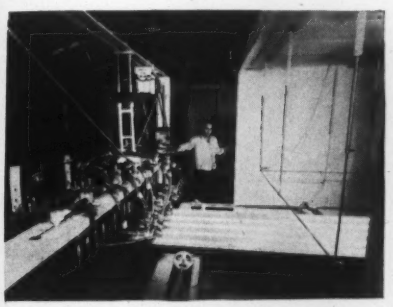
Rigid quality control has resulted in a fine production record for Alumalure at NSE's Birmingham plant.

Full time NSE and Alcoa inspectors watchdog every foot of sheet throughout the production cycle. For chemical pre-treatment Alcoa specifies high standards of Government Specification MIL-C-5541. NSE selected and uses Alodine for "the best metal preparation treatment you can find." NSE management states emphatically, "There's no question about what Alodine has done for the preparation of aluminum for painting. We don't have paint failures. We don't have customer rejects."

An "extra" plus from Alodine—Alcoa finds additional customer appeal in the gold coat Alodine creates on Alumalure backing which provides a pleasing antique decorative finish for building interiors.

If you want—corrosion resistance, lasting paint adhesion, rejects slashed to the vanishing point and sales ammunition that helps sell products—investigate Alodine, the industry's first and today's standard conversion coating chemical for aluminum!

* Amchem's trademark for its conversion chemical coating for aluminum.
** Trademark of Aluminum Company of America.



After treatment with Alodine, a ribbed siding sheet is painted employing Ransburg electrostatic paint equipment. NSE can run two sheets in tandem, accomplishing 60-lineal feet per minute painting.

NSE Executive Vice-President John Montgomery (left), Plant Manager R. Cater Lee, and Alcoa (quality standards) specialist J. Shea (right), inspect "3D" Alumalure sheet.

The massive equipment shown here is an ultra-modern, newly installed Lanly oven for handling Alumalure sheets.

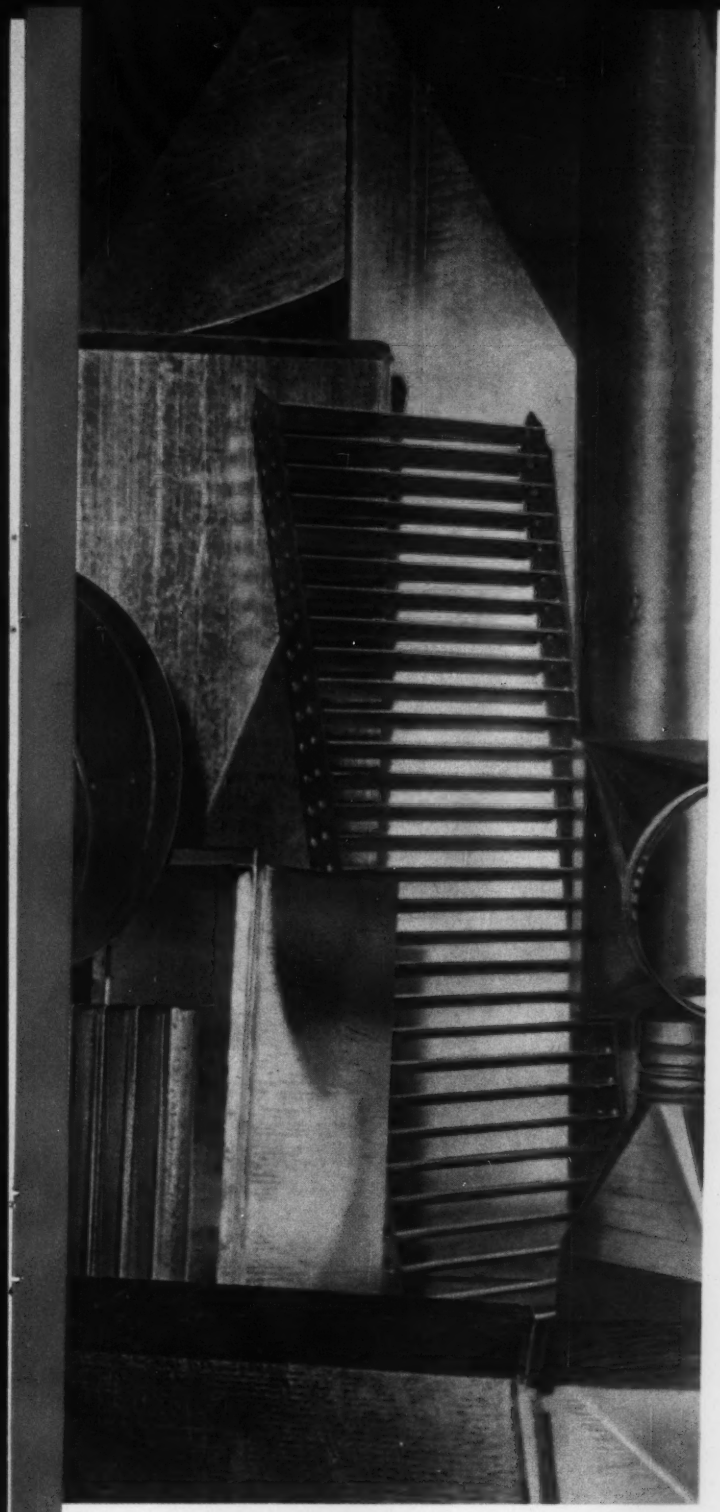
AMCHEM **ALODINE**

Amchem is a registered trademark of
AMCHEM PRODUCTS, INC. (Formerly American Chemical Paint Co.)
AMBLER, PA. • Detroit, Mich. • St. Joseph, Mo. • Niles, Calif. • Windsor, Ont.

Write for free bulletin 1424C, outlining the uses and many different types of Alodine available for aluminum fabricators and processors.

For more information, turn to Reader Service card, circle No. 397

For more information, circle No. 427 ➤



tufkote

New high quality Youngstown galvanized sheet from the industry's newest, finest mill

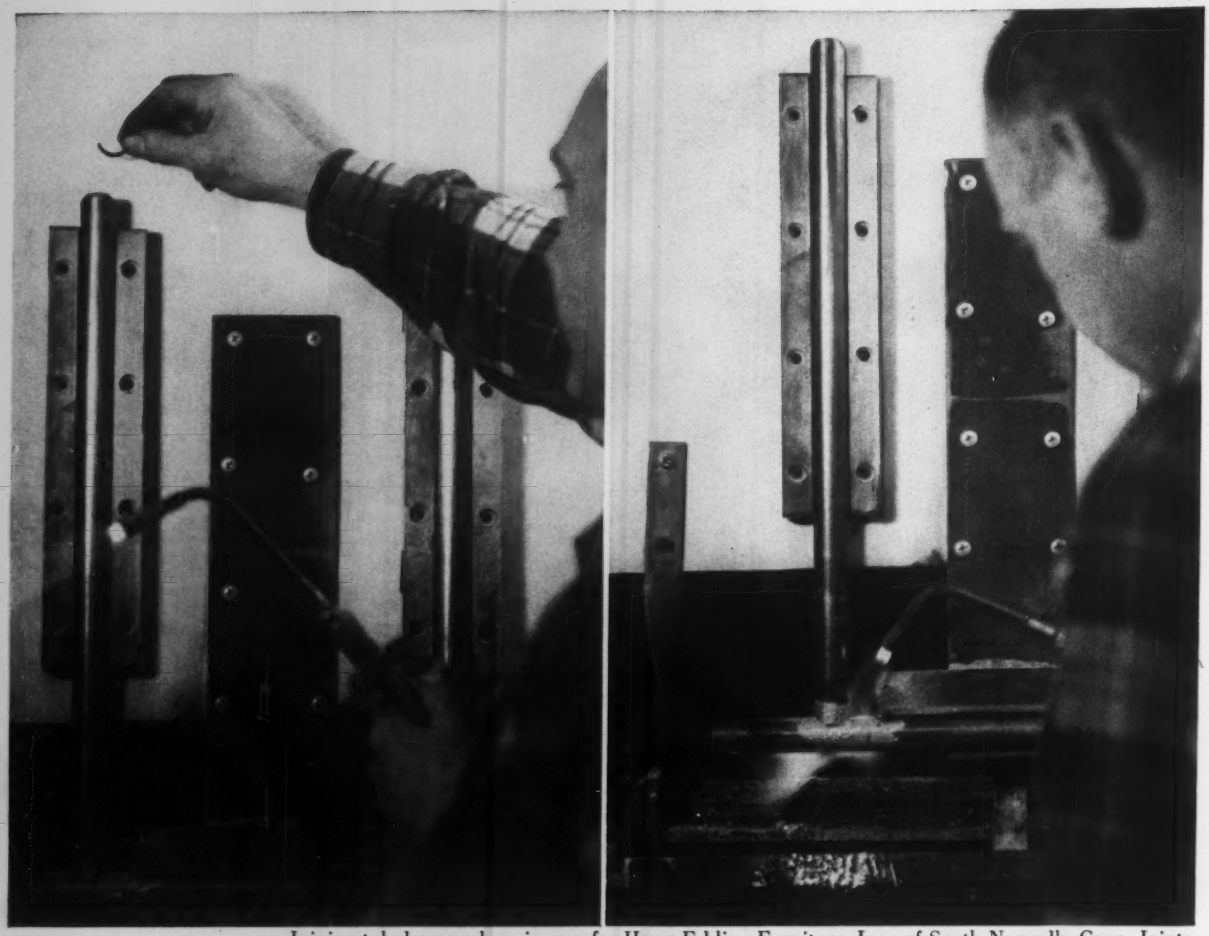
A new 848-foot long continuous Sendzimir galvanizing line is rolling at Youngstown's giant Indiana Harbor Works. It is the most modern line in the world. Every month it produces 11,000 tons of **tufkote,** shiny new Youngstown galvanized sheet steel in coils, cut lengths; flat or corrugated.

Youngstown **tufkote** gives you a full range of coatings with absolute adherence. You get superior corrosion resistance, better appearance. You get better workability, better forming properties of both zinc coating and base metals. Test it, bend it, draw it, cut it, crimp it. Youngstown **tufkote** offers you the best combination of strength and workability—is unequaled in superior properties.

Get the exact coating, finish and adherence your specifications call for. Specify Youngstown **tufkote.** And count on fast delivery. Like over 800 other Youngstown steel products, new **tufkote** is Youngstown-made from ore to steel to mill to final cut sheet and coil. You can depend on quality and service when you order steel from Youngstown.

Youngstown – growing force in steel

For full details on Youngstown **tufkote** galvanized sheet, write: Dept. 10-C
The Youngstown Sheet and Tube Company, Youngstown, Ohio



Joining tubular members is easy for Howe Folding Furniture, Inc., of South Norwalk, Conn. Joints are fluxed with Handy Flux, a half-circle preform of EASY-FLO brazing alloy is dropped down the tube and a torch is applied. Result: A smooth, strong joint quickly and economically made.

How Handy & Harman Brazing Alloys

GIVE FOLDING FURNITURE 100% JOINT RELIABILITY

The experience of Howe Folding Furniture, Inc., with silver brazing merits close attention if your operations involve metal-to-metal joining of any kind. Howe manufactures folding metal tables and seats for commercial, industrial and institutional use. You can imagine the hard usage the furniture has to take—yet survive indefinitely.

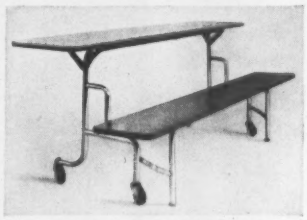
Some years ago, it was Howe's practice to purchase prefabricated steel tubular assemblies in which the joints were brass brazed on the outside surface. To improve their product, Howe thoroughly tested all joining methods, and decided to go over to silver brazing in their own plant, using Handy & Harman EASY-FLO Alloys 45 and 35. Look at the results:

Complete Joint Reliability: Since adopting silver brazing, Howe has completely eliminated the problem of broken joints.

Economy: Silver brazing costs Howe less than other methods, requires less heating time, simpler equipment, much less cleaning and grinding of joints.

Appearance: Silver brazing provides a smoother, more attractive joint, that can be plated directly.

Is it any wonder Howe says: "We'd stay with silver brazing even if it cost more." There are few fields of industrial activity where the strength, high production rates and economy afforded by the Handy & Harman family of silver brazing alloys cannot improve the look of the balance sheet. Interested in complete details? Just write for a copy of our Bulletin 20 — it's packed with engineering and application data.



Howe cafeteria table-bench is converted to an auditorium bench with backrest in a single motion. Silver brazed joints easily absorb strains.

HANDY & HARMAN

850 Third Avenue, New York 22, N.Y.
PLaza 2-3400

For more information, turn to Reader Service card, circle No. 402

Silicone rubber compounds stand exposure to 9000 F for 6 min seven times better than present nose cone materials, according to a research report. After 6 min, temperatures on the back of the specimens reached only 450 F. A hard surface crust had formed leaving 70% of the specimen flexible and undamaged.

Source: Silicone Products Dept., General Electric Co., Waterford, N.Y.

Integral aluminum wheels and brakes for cars are said to outperform their steel disk counterparts. In a dynamometer test consisting of 16 consecutive stops from 70 mph, temperature of the aluminum wheel, hub, and drum unit leveled off at 500 F midway through the test. Stopping times ranged from 7.5 to 9.5 sec. A steel wheel with iron drums reached 925 F, and stopping times ranged from 7 to 25 sec.

Source: Kaiser Aluminum & Chemical Corp., 300 Lakeside Drive, Oakland 12, Calif.

Deep-drawn polyester endcaps are being used to insulate the r-f heater coils in microwave cooking units. A cap covers one face, the core and outside of the coil. Polyester sheet was selected for its high dielectric strength, heat resistance and formability. Draws range from 1:1 to 1:4 for this and other equipment.

Source: Silicone Insulation, Inc., 1383 Seabury Ave., Bronx 61, N.Y.

Supersonic salvos of water droplets fired at metal specimens are being used to study the erosion of turbine blades, according to a recent report. A drop traveling at 3400 mph punctures thin sheet metal or makes a sizable dent in thick pieces of stainless steel, copper and other metals. Tests show tungsten carbide and cobalt superalloys to be the most resistant metals. The impacts also generate unexplained bursts of light.

Source: Westinghouse Electric Corp., Box 2278, Pittsburgh 30.

Foam sheets of polyester-type urethane used to thermally insulate chemical processing equipment are said to cost 30% less to install than magnesia and glass fiber sheets. Vinyl skins on each sheet prevent moisture from deteriorating the sheet's insulating properties. Operating surface temperatures range from 50 to 250 F.

Source: Reeves Brothers, Inc., 1071 Ave. of the Americas, New York 18.

Diamonds have been produced by explosive shock in rhombohedral graphite. The diamonds, fund in the graphite by x-ray and electron diffraction analysis, are reported to be generally 10μ or less in dia.

Source: Poulter Laboratories, Stanford Research Institute, Menlo Park, Calif.

A superconducting transformer operating at –452 F is said to have a 15-w output. Previous cryogenic transformers failed because their magnetic field restored electrical resistance and destroyed the superconductivity. In the new design, interleaved layers of primary and secondary windings cause individual magnetic fields to cancel and minimize the total field strength.

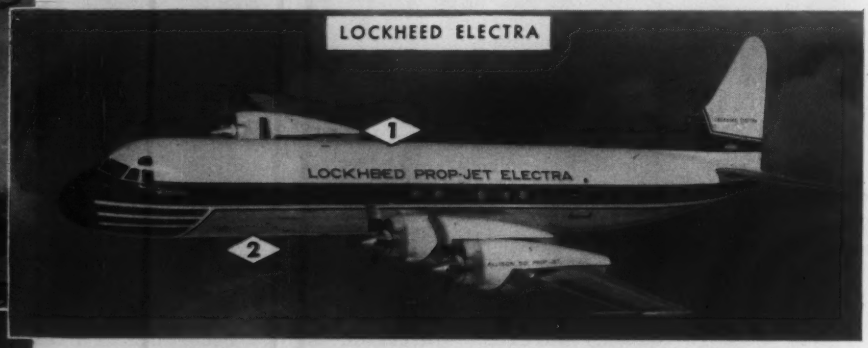
Source: Arthur D. Little, Inc., Acorn Park, Cambridge, Mass.

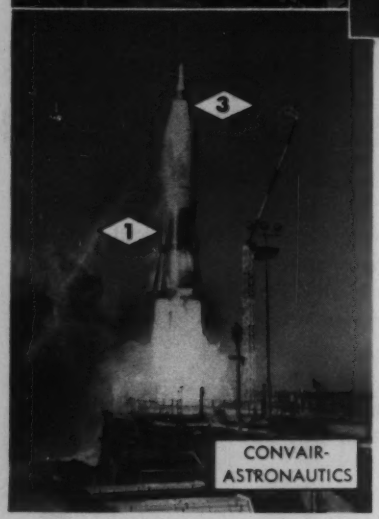
for protection on light metals

you need IRIDITE®

PROCESS ENGINEERED CHROMATE CONVERSION COATINGS

1. Iridite protects against high altitude weather extremes and against corrosion by hydrocarbon fuels, such as gasoline and kerosene.
2. Iridite provides a highly protective non-porous paint base.
3. Iridite protects against corrosive storage conditions.





And, Iridite gives you these additional advantages:

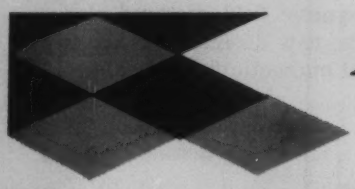
ON ALUMINUM—needs only normal pre-cleaning. Film withstands cold forming or bending. Easily heliarc welded. Unusually low electrical resistance. Clear, yellow or dye-colored finishees.

ON MAGNESIUM—short immersion, room temperature solution, no electrical equipment. Corrosion protection relatively unaffected by high drying temperatures. Applicable to all alloys. Low electrical resistance. Color ranges from light gray to dark brown.

IRIDITE—a specialized line of chromate conversion coatings for non-ferrous metals. Easily applied at room temperatures with short immersion, manually or with automatic equipment. Forms a thin film which becomes an integral part of the metal. Cannot chip, flake or peel; special equipment, exhaust systems or highly trained personnel not required.

Iridite is approved under government and industrial specifications.

For complete information on Iridite, contact your Allied Field Engineer. He's listed under "Plating Supplies" in the yellow pages. Or, write for FREE TECHNICAL DATA FILES.



Allied Research Products, Inc.

4004-06 EAST MONUMENT STREET • BALTIMORE 5, MARYLAND

Affiliated operations in principal countries

For more information, turn to Reader Service card, circle No. 439

Gas refrigerator, *discontinued in 1956, is making a comeback with the help of materials specialists who recommended using thin-wall urethane foam insulation to bring cabinet size and storage capacity in line with comparable electric refrigerators. The RCA Whirlpool weighs 131 lb less than its predecessor.*

How Materials Groups Help Build Appliances

These groups, composed of a variety of materials specialists, evaluate materials for new designs, initiate materials changes in existing products, and prepare materials specifications. The object: better and less expensive household appliances.

by John A. Mock, *Assistant Editor, Materials in Design Engineering*

■ Materials groups in the appliance industry are involved in a broad spectrum of materials projects ranging from evaluating steels to researching thermoelectric materials.

An engineer in the materials department at a large appliance plant says, "It's easy to pick a material for a specific appliance application when you don't have to think about cost or availability. The hard part comes when you have to recommend the lowest cost, most readily available material that can go through production with a minimum of scrap and can withstand twisting, turning, pounding, washing and a hundred other different things occurring in an appliance."

But he says his work in materials evaluation and selection has been made a lot easier in recent years with the introduction of new tests and equipment. "If we haven't got equipment to run a special test we design and build it in our lab," he says. One appliance maker designed and built a machine to simulate shaving with an electric razor.

Another engineer says his lab-

oratory is equipped to do things "all the way from studying the molecular structure of a material to seeing how well the material stands up in a badly run household."

Almost every appliance maker reached in the survey said it had a laboratory where all types of engineering materials are evaluated. In many cases the laboratory serves three functions: 1) evaluating new materials, 2) checking established materials for new applications, and 3) testing materials used in present products.

The survey indicates that at least half of the leading companies in the small and major appliance fields have a group, person or persons whose primary job is concerned with engineering materials. And there are over 1000 materials specialists in the employ of the companies surveyed.

Here is what the survey shows about the organization and duties of such groups.

Small appliances *Examples of current materials activity. How materials groups are organized and what they do.*

Evaluating and recommending materials to meet design and service requirements is the most important function of materials specialists at Scott & Fetzer Co. in Cleveland, the survey shows. This vacuum cleaner manufacturer has a group of six materials specialists, headed by Charles H. McFarland, in the engineering department. In addition to evaluating and recommending engineering materials, they also initiate materials changes in present products, supervise testing of materials, solve materials problems encountered during manufacturing, prepare materials specifications, and handle vendor relations.

Irons, floor polishers, too

At Hoover Co. in North Canton, Ohio there are 15 people working in the Materials and Processes Dept. whose job it is to evaluate and recommend engineering materials for use in the company's line of vacuum cleaners, floor washers and polishers, and irons. The group, headed by Frank A. Martin, also prepares materials specifications, helps solve materials problems encountered during production, and handles vendor relations in cooperation with the purchasing department. The group was organized in 1955 and provides its services to the research, engineering, design and manufacturing departments. It is organized according to the various types of materials used.

Alfred J. Huck, chief engineer at Knapp-Monarch Co., St. Louis, says there are seven materials specialists in his company's engineering department whose primary job is evaluating and selecting materials that go into the company's line of portable domestic appliances. Most of the people in his group are technical graduates.

Stainless steel shaver head

An example of materials evaluation and selection by a materials group in the small appliance field can be found in a recently introduced electric shaver manufactured by Schick Inc., Lancaster, Pa. Under the direction of David Wallace, metallurgist, the five-man materials group in the company's engineering department recommended using stainless steel for the shaver head instead of the traditional chromium-plated SAE 1095 steel. Reason: an extensive research program conducted by the group showed that stainless steel is durable, has better corrosion resistance than plated 1095, and has good consumer appeal because it can be washed.

Another example of materials evaluation and selection by Schick's materials group is the use of nylon 6 in place of melamine for the case of the new shaver. The group found that nylon's superior toughness, flexibility and shock resistance, combined with its lower density and ease of molding, afforded a better material for shaver cases when compared with melamine. Also, nylon 6 can be injection molded at a cost saving compared to melamine which has to be compression molded.

Mr. Wallace is assisted in his work by Ralph Masten, chemist, whose work includes the evaluation and selection of plastics, rubber and adhesives.

Schick's materials group was formed in 1954. In addition to evaluating and recommending engineering materials, the group also initiates materials changes in present products, advises on materials selection by others in the company, supervises testing of materials, solves materials problems encountered during manufacture, prepares materials and process specifications, and disseminates materials data.

New group at Silex

The duties of the newly formed Materials Evaluation Dept. at

How the Appliance Industry Is Organized

The appliance industry is generally divided into two major categories as follows:

1. Small appliances

- **A.** Cooking—food mixers, blenders, broilers, toasters, coffee makers.
- **B.** Maintenance—irons, vacuum cleaners, floor polishers, sewing machines.
- **C.** Comfort—fans, shavers, electric blankets, heat lamps.

2. Major appliances

Home laundry equipment, dishwashers, stoves, ranges, freezers, food waste disposers, refrigerators, air conditioning units.

Silex Co. in Chicago are somewhat similar to those of the materials group at Schick Inc., except that materials specialists at Silex do not prepare specifications. Silex, which spends over $3 million per year for materials going into its products, has six men in its engineering department to assist and handle materials problems as they occur at the design level.

Major appliances *Materials groups aim to speed up production by using more plastics. Research activity in thermoelectric materials for cooling.*

There are many similarities between materials groups in the small and major appliance fields: groups in both fields are concerned with all types of engineering materials and have materials evaluation and selection as major functions. Also, materials groups in both fields are cost conscious and consider cost of a material a major factor in selection.

But materials departments in the major appliance field appear to be more concerned with finding faster methods for processing materials than groups in the small appliance field, the M/DE survey shows. One engineer in the field says, "Our industry uses a tremendous amount of engineering materials each year, and considerable cost savings can result if a new process can be used to shorten or completely eliminate a production step."

Materials groups at GE

An example of a large volume user of materials is General Electric's Major Appliance Div. in Louisville, Ky., which in a typical year consumes 150,000 to 200,000 tons of steel along with 14,000 tons of plastics, 10 million pounds of aluminum and 500,000 gal of paint. The estimated annual expenditure for all types of engineering materials consumed at the plant is $100 million.

General Electric has 150 materials specialists working at its Major Appliance Div., eight at its Hotpoint Kitchen Appliance Div. in Chicago and four at its Air Conditioning Dept. facility in Tyler, Tex. The group at the Major Appliance Div. works under Samuel E. Q. Ashley. It is divided into eight laboratories with a manager for each (see chart).

Research at the Major Appliance Laboratories is often supplemented by work done at GE's 1200-man Research Laboratory in Schenectady, N. Y.

"Principles, processes and materials are the three most essential elements of laboratory service at the Major Appliance Div.," according to Ashley.

He says the laboratory is currently spending a great deal of time and energy to find efficient thermoelectric materials for cooling. The Metallurgy and Ceramics Laboratory, under the direction of Dr. Robert L. Hadley, is doing a lot of work on processing thermoelectric materials. Hadley says the present cost of these materials (about $1000 per lb) will have to be reduced substantially to make them practical for use in mass-produced cooling devices. Research efforts on alloying and processing techniques are aimed at bringing down the cost.

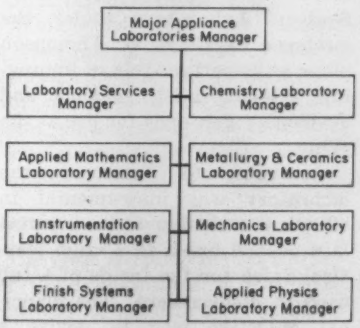
Hadley's group is also concerned with the long-time mechanical properties and bimetallic corrosion of bismuth telluride. The GE metallurgist says bimetallic corrosion could be a major problem with this material.

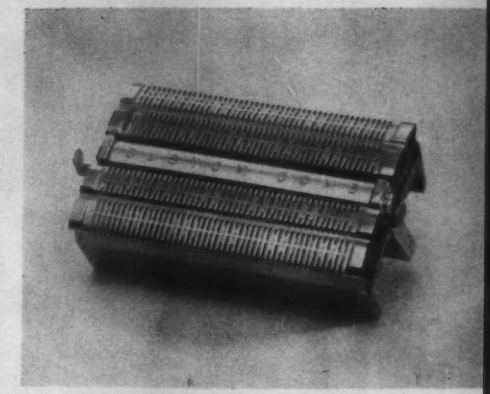
Other work being done by the Metallurgy and Ceramics Laboratory includes: 1) production and laboratory studies of one-coat porcelain-enameled parts; and 2) development work on die casting nonstandard aluminum die casting alloys to obtain better mechanical properties and better corrosion resistance than are obtainable in present standard die casting alloys.

According to Hadley, over 100,000 one-coat porcelain-enameled parts have been made in production and are presently being field tested. There are still some problems to be worked out in one-coat porcelain enameling. The biggest problem seems to be getting good edge coverage on resistance welds. Hadley believes this and other problems involved with one-coat porcelain enameling will probably be solved by redesign rather than by materials research.

The Chemistry Laboratory at the Major Appliance Div. is headed by Robert W. Finholt who holds a Ph.D. degree in chemistry from Purdue. Before coming to GE, Dr. Finholt taught chemistry at Union College. Talking about materials education, he says, "It is disturbing to note that in most universities the study of polymers as materials takes a back seat, yet most of the chemical engineers and chemists coming out of our

Administrative Setup of Materials Group at GE's Major Appliance Division





Stainless steel head *is used on Schick's new compact electric shaver. Individual cutter teeth in the head are 0.013 in. wide and 0.0025 to 0.0030 in. thick.*

***High speed camera** is used by John F. Thompson and Roger McWilson of the Applied Physics Laboratory at GE's Major Appliance Div. to investigate grinding action of a garbage disposal unit.*

schools today will be working in the field of polymers in one way or another for the rest of their lives."

Data on plastics needed

The laboratory is keenly interested in plastics and has started an active research program to obtain more reliable property data on this group of materials.

"What we need," says Finholt, "is good mechanical data on plastics, and I'm not talking about the conventional ASTM type of information, as valuable as that is. What I am talking about is real engineering data that can be used for design purposes and can be counted on. We need more information on plastics forming processes. We also need flame retardant plastics. This is not necessarily a serious drawback, but we do need material in a house that either burns very slowly or not at all. We need weather resistant plastics for things that might be outside the house. And we need heat resistance to about 250 F for most plastics applications."

What about the trend to use of plastics in appliances? Will it continue? According to Finholt, "Plastics usage in American appliances has increased tenfold in the last eight years, and their use is continuing to grow. Because of economics, it is likely that the average American major appliance will contain some 40 lb of plastics per unit in another eight years."

Savings in finishing

Paint and enamel finishing of products manufactured at the Major Appliance Div. requires 14% of the total manufacturing area and 10% of the total work force. Consequently, the Finish Systems Laboratory under the guidance of Ralph G. Thompson plays an important role in improving present finish systems and developing new ones for use at the plant.

According to Thompson, the laboratory was instrumental in effecting a change from a porcelain enamel finish to a vinyl plastisol finish for the inside of a tub used in dishwashers. The principal objective was to devise a means of using single-wall construction and thereby reduce manufacturing costs. Use of a sprayed vinyl plasticol coating made possible single-wall construction. The amount of steel per unit has been reduced from 55 to 48 lb, and manufacturing costs have been cut 10%. The plastisol coating also serves as a cushion for the dishes, it does not chip, and its continuity eliminates the unsanitary indentations of the previous design.

Solid state research

Another important part of the Major Appliance Laboratories is the Applied Physics Laboratory headed by Briggs Gettys. Solid state research on thermoelectric materials is one of the most important programs now going on in the laboratory. Bismuth telluride is coming in for a great deal of study. But Gettys, like Hadley of the metallurgy and ceramics section, says this material will have to be greatly improved before it becomes practical for use in refrigerators and other mass-produced cooling devices. Also, tellurium is scarce and expensive. Gettys believes less costly and more efficient thermoelectric compounds will probably come out of solid state research.

Westinghouse's central group

Another large company in the major appliance field is Westinghouse Electric Corp. which spends about $170 million per year for engineering materials going into its line of consumer appliances. In contrast to GE which has a large group of materials specialists at its major appliance plant in Louisville, Westinghouse concentrates most of its materials work in a centralized department in Pittsburgh. However, there are materials groups doing evaluation, specification and other types of work at major appliance plants in Mansfield and Columbus, Ohio. Men in these groups are experts in materials problems that are most prevalent in their own plants.

Materials activities at the Mansfield and Columbus plants are supported by work done in the centralized department in Pitts-

burgh. This 470-man department is headed by Clyde E. Arntzen. It is divided into nine sections or departments: 1) metallurgical, 2) magnetic, 3) insulation and chemical, 4) solid state electronics, 5) ceramics, 6) composition and performance, 7) experimental design and statistical analysis, 8) standards, and 9) radiation and nucleonics.

Specialists working in these various departments include metallurgists, electrical engineers, physicists, chemical engineers, chemists, physical chemists, ceramic and glass technologists, inorganic chemists, ceramic engineers, mechanical engineers and statisticians.

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A smaller, three-man group

In contrast to materials departments at GE and Westinghouse which are organized by type of material, the three-man materials group in the Appliance Div. of American Motors Corp. in Detroit is organized by product or part. Headed by chief engineer George T. Bauer, the group is part of the engineering department and serves personnel in the company's research, design and manufacturing divisions. Two of the most important jobs performed by the group are advising on choice of materials, and solving materials problems encountered during production.

Foam for a gas refrigerator

Specialists in the materials laboratory at Whirlpool Corp., St. Joseph, Mich. have been instrumental in effecting a number of materials changes in the company's line of major appliances to improve product performance and speed production.

For example, the four-man group recommended using thin-wall urethane foam in place of glass wool as insulation for a new model gas refrigerator. The rigid urethane insulation provides a sizable reduction in outside dimensions compared to previous models and permits a 21% increase in food storage space.

The urethane insulation is a fluorocarbon-blown polyether type and is installed in the walls, in the cabinet and around the evaporator unit of the refrigerator as it moves through production.

Whirlpool's group was formed in 1959 and is managed by David Johnson. One of the most important jobs done by the group is advising on and reviewing choice of materials made by others in the company.

Finishing air conditioners

Chrysler Airtemp Div. of Chrysler Corp. maintains a materials group at its plant in Dayton, Ohio. Headed by Robert C. Hartman, the Materials Engineering Section is responsible for the selection and evaluation of all production materials going into a line of air conditioners. The materials group has grown from a one-man operation in 1951 to five people at present: three of the five people are technical graduates.

Mr. Hartman indicated that, although his group gives technical advice to other sections in the engineering department on purchased components, the majority of the group's time is devoted to specifying raw materials, checking materials processing in the plant, and analyzing product reliability in relation to materials used.

By careful selection of the proper synthetic enamel finishes, method of application, phosphating treatment, and type of surface (plain or galvanized steel), the materials group was able to substantially increase the corrosion resistance of the company's line of air conditioners and at the same time reduce over-all finishing costs.

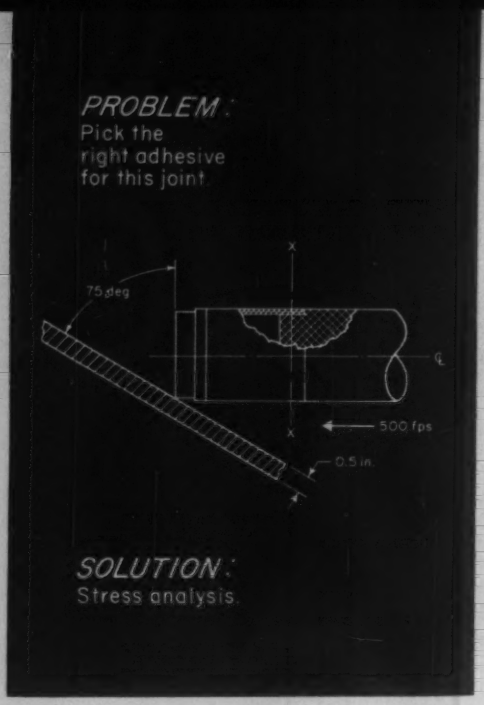
Another contribution made by the materials group at Chrysler Airtemp was their work in the development of the company's line of residential and small commercial hermetic compressors. By making wide use of aluminum die castings and powdered metal parts, they helped design a unit that required a minimum of high cost machining operations.

Hartman believes that material specialists "are a very necessary part of the total engineering effort, and that their worth will increase as they have the opportunity to apply the continuing flow of new materials and processes to present and future product designs."

Acknowledgments

We would like to express our appreciation to all those who cooperated in the survey, and particularly to the many helpful people in the following companies:

Chrysler Airtemp Div. of Chrysler Corp.
General Electric Co.
Schick Inc.
Westinghouse Electric Corp.
Whirlpool Corp.



A Case History:

How to Design

Here's how the analytical approach solved a dynamic loading problem without extensive testing.

by R. F. Wegman, M. J. Bodnar, and K. J. Taglier, *Plastics and Packaging Laboratory, Picatinny Arsenal*

■ Too often integrity of bonded joints is jeopardized by 1) attempting to substitute adhesives for other fastening methods without redesigning the joint for adhesive bonding, 2) using standard lap-shear strength data for adhesive selection without considering whether shear strength is the critical strength requirement in the joint, and 3) using static strength data with little thought to whether the joint will actually undergo dynamic loading in service.

Much trial-and-error testing can be eliminated by using an analytical approach. The science of stress analysis is well developed. Putting it to use, along with adhesive evaluation methods tailored to the anticipated service conditions, should result in a bond of optimum efficiency obtained with a minimum of prototype testing.

How stress analysis was used

To prove the validity of the analytical approach we set up a theoretical problem.

The problem—As shown in the sketch above, the joint consisted of a hollow steel tube in which was bonded a cylindrical aluminum rod. The bond was required to withstand impact loading resulting from the end of the steel cylinder striking a high strength aluminum (Dural) plate with an impact velocity of 500 fps at a maximum angle of obliquity of 75 deg. Under these conditions, the structure must penetrate the 0.5-in. plate in 85 μsec or less. The plate has a shear strength of 3×10^4 psi.

Analysis of stress—To determine the requirements of the joint, conventional stress analysis techniques were used to predict both the types and magnitudes of stresses acting within the bond. A summary of the calculations is given in the accompanying box.

Under the conditions given, the total force acting on the adhesive bond was first determined. Then it was found that under these conditions, compressive, tensile and shear stresses would be set up in the circumferential area of the joint.

The shear and tensile stresses were found to be 2080 and 134,000 psi respectively. Since the shear stress is the lower, it is the critical strength factor. And the strength of the bonded assembly is dependent on the adhesive resisting this 2080 psi shear strength when loaded over a time interval of 85 μsec or less.

Adhesive selection

Given the above stress requirement, the other requirements of the adhesive were established:

1. Must adhere to both steel and aluminum.
2. Must be resilient to withstand impact loading.
3. Must be a low viscosity, unfilled adhesive since the fit is tight, with little clearance between adherends.
4. Must be curable at room temperature.

Initial screening evaluation of a number of adhesives indicated that an epoxy-polyamide system would meet all the requirements given, if it provided the shear strength required. The material has low shrinkage, and its flexibility permits distribution of stresses induced during the room temperature cure.

Loading rate evaluated — Lap shear specimens of aluminum and steel with length-to-width ratios approximately that of the structure were tested. At essentially static rates (i.e., 2 min to break) shear strength values approaching

for Adhesive Bonding

2500 psi were obtained at temperatures ranging from −65 to 140 F.

Since high loading rates would occur in service, we evaluated specimens on a test device actuated by a compressed gas-driven piston, obtaining loading rates as high as 1200 μsec to failure. Results indicated that shear strength values increased with increased loading rates. Values increased from about 4800 psi at failure times of 7200 μsec to about 6200 psi at 1200 μsec. From these data, we felt that at the higher loading rate required by the theoretical problem, i.e., less than 85 μsec for failure, the epoxy-polyamide system would have substantially higher shear strength than the 2080 psi requirement derived from stress analysis.

Actual use: the acid test

From the results of this analytical approach, a prototype was constructed and bonded with the epoxy-polyamide adhesive selected. The prototype performed satisfactorily in testing, proving out the calculations and eliminating the need for multiple prototypes to evaluate various possible adhesive systems which might have appeared suitable from initial screening procedures.

A note of caution: Of course, the stresses discussed in this problem are not the only ones that must be considered for a complete stress study of an adhesive-bonded product. Other stresses would be created by conditions such as environmental temperature and differences in expansivity of adherends and adhesive.

Calculations involving these stresses would be much more complicated. This simplified study is presented only to indicate the value of the analytical approach in designing for adhesive bonding.

Stress Analysis— How It Was Done

Following is a highly simplified summation of the conventional stress analysis steps taken in analyzing the problem structure.

1. *Determine force acting on bonded joint:* First determine the moment at the adhesive-bonded joint *X-X*. Fig 1 shows linear force required for penetration of the 0.5-in. Dural plate. Force will be approximately equal to mass m times deceleration $\bar{a}$. Deceleration $\bar{a}$, of course, is a function of the velocity change ΔV between the two sides of the plate, which in turn is a function of impact velocity and the energy required to shear the plate.

The vertical component of the force system in the plate has a reaction, $+R$. The force system of the mass center has a vertical component, $-R$.

Summing these components:

$\Sigma R = m\bar{a}\cot\phi - m\bar{a}\tan\theta$

$\Sigma R = m\,\bar{a}\,(\cot\phi - r/L)$

where r = radius and L = distance to center of gravity.

At the bonded joint, line *X-X*, moment M_{xx} can be shown as:

$M_{xx} = m\bar{a}\,(\cot\phi - r/L)l$

$= W/G \cdot \Delta V/T \cdot (\cot\phi - r/L)l$

where W = weight, G = gravity, and T = time.

The free body diagram, Fig 2, for equilibrium about point O, shows that:

$-F_o d + \Sigma Rl = 0$, and $F_o = Mx - x/d$

Thus, F_o can be calculated as 19,600.

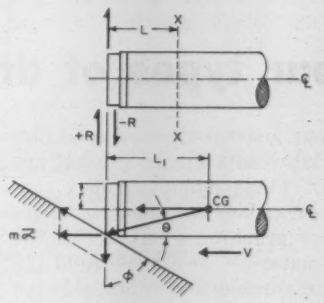
2. *Determine stresses in bond:* The bonded area, of course, is equal to the circumference times the width, w, of the joint. Fig 3 depicts the stresses set up in the bonded joint by rotation about point O, i.e., compressive (σ_c) upper and lower butt joints, and tensile (σ_t) stresses at the shear (σ_s) stresses in the circumferential surface of the joint.

Assuming that the joint is semi-rigid and that force F acts on the complete bonded area simultaneously, and assuming that all but 25% of the upper surface is contributing to resistance to tension, the stresses in the adhesive bond that will be resistant to the shear and tensile stresses set up by the force can be calculated:

$\sigma_s = F_o \div \pi d_s w$, and $\sigma_t = F_o \div 0.75\,\pi\,(r_o^2 - r_i^2)$

where d_s = diameter of bonded surface.

Proper substitution results in shear stress in the adhesive bond of 2080 psi; tensile stress in the adhesive bond of 134,000 psi.



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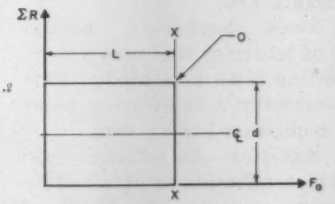

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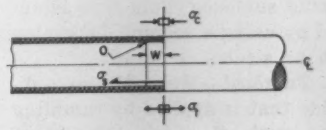

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The authors wish to express their appreciation to F. Saxe of Picatinny Arsenal for his helpful suggestions and guidance, and W. C. Tanner for his assistance in obtaining high rate data.

Solid-Film Molybdenum

show promise for use at temperatures up to 900 F. In addition, the permanent nature of these coatings is useful where long-term wear protection is needed.

by E. B. Palmer, *Convair-Ft. Worth, a Div. of General Dynamics Corp.*

■ Molybdenum disulfide lubricants have gained rapid acceptance as a replacement for conventional lubricants in special applications. Ordinarily a "dry" lubricant such as molybdenum disulfide requires a petroleum solvent vehicle to carry the lubricating particles. However, the problem of petroleum evaporation at high temperatures has become acute—most petroleum vehicles start to oxidize at about 250 F, and can only be used up to 400 F even when containing special additives.

Because of the need for materials with better high temperature properties there has been a great deal of research recently on bonded and cured dry film lubricants capable of operating over a temperature range of -100 to 1500 F. Although this goal has still not been reached it now appears that some bonded-type dry film molybdenum disulfide lubricants can be used up to 900 F.

Four types of dry film lubricants

Four general types of solid film dry lubricants are in general use today. These lubricants may consist of either molybdenum disulfide or graphite, a mixture of the two materials, or a mixture of the two materials and other selected solids. Briefly, the four types of lubricants are:

1. *Resin bonded*—A bonded type of lubricant that uses a thermosetting resin as a binder. This is essentially a lubricating paint and requires a baking cure.

2. *Adhesive*—An adhesive type in which adhesion is obtained by intimate contact and affinity of the lubricating particles for the bearing surfaces. This type is applied by using a solvent dispersion such as alcohol or Freon.

3. *Tumbled*—Molybdenum disulfide that is applied by tumbling parts with the dry lubricating powder and a special medium such as cork, pine cones or asbestos. Although this coating is inferior to a bonded coating in load carrying ability and wear life, it is ideally suited for small parts—such as threaded fasteners and rivets—that are impractical to coat with a bonded lubricant.

4. *Metal-bonded* — A bonded solid film lubricant that uses a metal matrix bonding agent rather than a plastic resin. This lubricant is said to overcome some of the limitations of a resin-bonded lubricant. Indications are that the metal matrix lubricant may surpass the resin-bonded lubricant for some applications, e.g., it can definitely be used at higher speeds.

Of the four general types of dry film lubricants discussed above, resin-bonded type (No. 1) containing molybdenum disulfide and a thermosetting resin is presently proving to be the most practical and serviceable. Thus, this article will primarily be devoted to this type and will include reference to a recently developed Convair variation of the material suitable for use at 900 F.

Where to use them

Molybdenum disulfide lubricants bonded in a thermosetting resin are especially noted for their good tenacity, low coefficient of friction, and excellent ability to carry high bearing loads. They can be used to reduce friction and wear, and to prevent galling and seizing, in applications where:

- The presence of oil or grease is impractical or objectionable.
- Pressures and/or temperatures are beyond the limits of conventional lubricants.
- Tolerances will not allow the use of greases or oils.
- Location of surfaces renders relubrication difficult or impossible.
- Maintenance must be reduced.
- Fretting corrosion must be controlled.
- Improved assembly and removal of parts such as threaded fasteners and assembly pins is needed.
- Reliable operation of emergency and infrequently used mechanisms is important.

Where *not* to use them

Thus resin-bonded dry film lubricants are suited for a wide variety of applications. Theoretically, they could be used in any application that does not require a hydrostatically lubricated bearing. But note that they cannot be used where:

- Flushing of bearings is required.
- The lubricant is required to dissipate heat.
- Sealing characteristics are needed (as in valves).
- Bearing surfaces depend on line or point contact.
- Ball bearings and other anti-friction-type bearings are generally used. (Some exceptions to this rule will be discussed later.)

Disulfide Lubricants

Metal pretreatment is important

Careful and rigorous metal pretreatment is essential in order for a dry film lubricant to achieve its full performance potential. We will not attempt to cover here the recommended pretreatments for all types of surfaces. But bear in mind that different alloys may require different pretreatments.

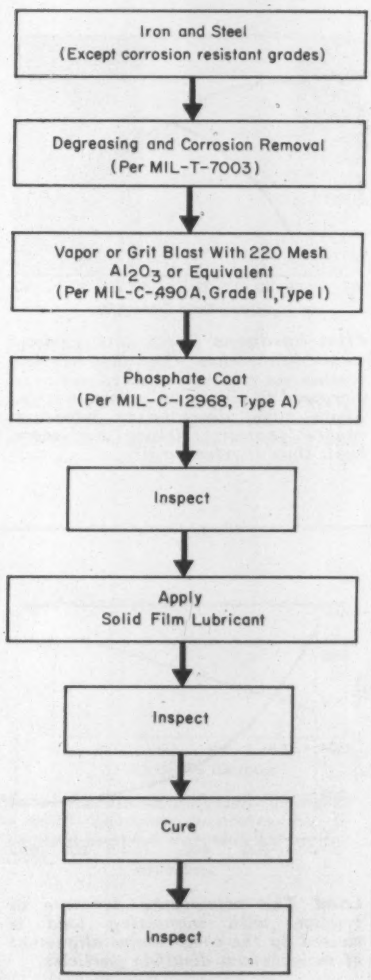
Surface finish counts

As shown in Fig 1, an initial degreasing and cleaning step is required before all other treatments. The variables that affect film life are monumental and from the start it is important that the right cleaner be used. After considerable experimentation we have found that perchloroethylene does the best job and leaves less surface film than any other solvent. Trichloroethylene and methylethylketone will also perform adequately. One of the best cleaners of all is boiling aliphatic naphtha; however, this material is considered impractical for production parts.

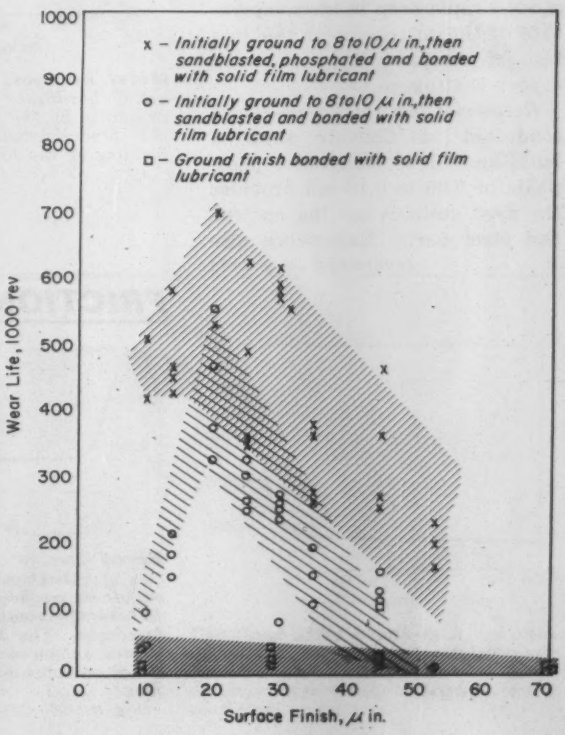
Until very recently a surface finish of from 30 to 60 μin. was considered ideal prior to the phosphating step. However, one lubricant manufacturer, who has probably done more testing than any other, has proved after more than 7000 hr of testing that a ground surface finish of 8 to 10 μin. followed by finishing to approximately 20 μin. provides a better bed for the solid film lubricant. The 20 μin. finish is produced by a vapor or sandblasting treatment with 220 mesh aluminum oxide or sand. Better results cannot be obtained with finer or coarser finishes or by using different abrasive media. Typical values for wear life vs surface finish are shown in Fig 2.

Phosphate treatments

A vast difference of opinion exists on this highly important step. Essentially, the purpose of phosphating is to: 1) promote adhesion between the solid film and the metal surface; and 2) prevent corrosion. Solid film lu-



1 Recommended treatment (left) for applying dry film lubricant to iron and steel (except corrosion resistant grades).



2 Wear life vs surface finish (right) data show the importance of surface finish and production methods.

bricants do not in themselves provide corrosion protection; indeed, some films have been known to promote corrosion.

One of the big problems in using a phosphate treatment is that no two suppliers agree on application procedures. This is understandable because a great many variables are involved, such as: 1) strength of solution, 2) amount of free iron to add as an accelerator, 3) length of time to leave the part in the bath, 4) temperature, and 5) amount of deposit buildup. Experimentation is essential in order to arrive at the best procedures.

Following are recommended procedures for most carbon steels and alloys such as 4130, 4135, 4340, etc.

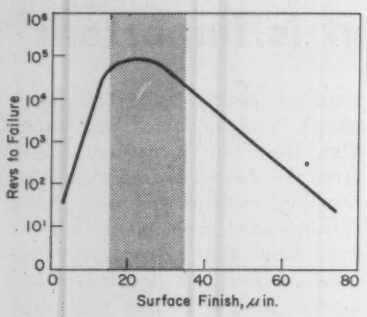
Bath temperature — Temperature of the phosphate bath is very critical; variation of but a few degrees can mean the difference between a fine, granular deposit and a coarse, structurally weak deposit. It appears that a bath temperature of 205 (±2 °F) is best. The parts should also be preheated to about this temperature. Otherwise when a cold part is immersed in the solution it will cause a rapid drop in the temperature of the solution near the surface of the part, thus producing a poor coating.

Recommended thickness—Tests conducted at Convair show a build up of iron manganese phosphate of 0.09 to 0.16 mil provides the most suitable coating on iron and steel parts. Experience also

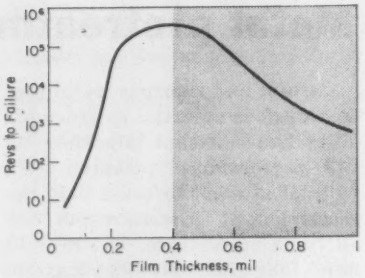
(continued on p 126)

Life, Wear and Frictional Properties

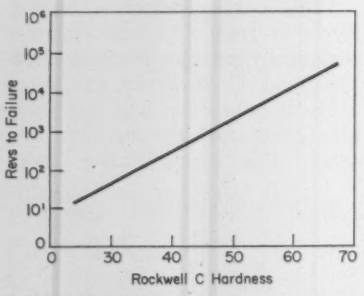
FILM LIFE . . .



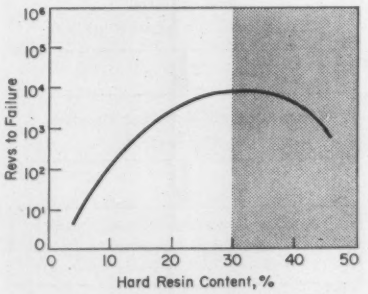
Surface finish *The lubricants have greater film life when surface finish is in the range of 15 to 35 μin. This is because adhesion cannot be obtained on highly polished surfaces; moderately rough surfaces provide a better base.*



Thickness *Optimum film life is obtained when the lubricant is 0.2 to 0.6 mil thick. The peak in the curve is due to the fact that over 0.4 mil the cohesion of particles is greater than their adhesion to the surface.*

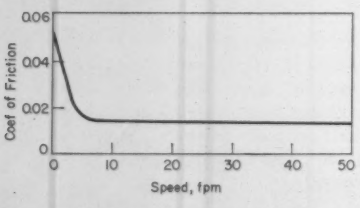


Metal hardness *Life increases as metal hardness increases. This is explained by the fact that the life of the film depends on the surface rigidity of the base metal.*

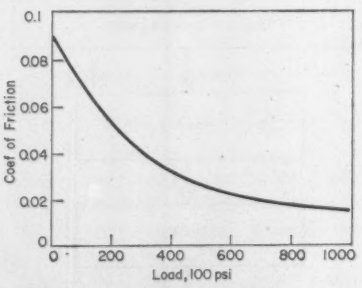


Film hardness *Tests with various formulations show that film life increases as amount of hard resin is increased to maximum of about 30%. Above 30%, decrease in lubricant causes greater friction and more heat, thus shortening life.*

FRICTION . . .

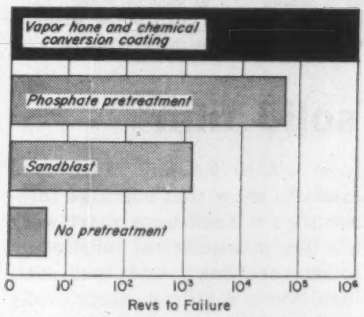


Speed *Due to the unusual properties of resin-bonded molybdenum disulfide its coefficient of friction tends to become virtually constant as speed increases. The high initial friction values shown are caused by unoriented particles of molybdenum disulfide.*

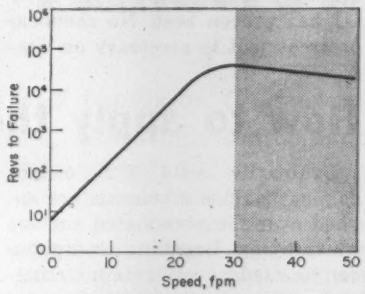


Load *The noteworthy decrease in friction with increasing load is caused by the compressive alignment of molybdenum disulfide particles.*

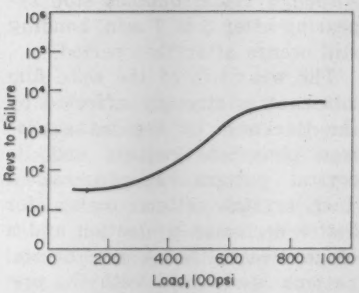
# of Resin-Bonded Molybdenum Disulfide Lubricants



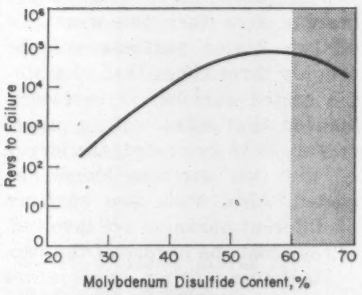
Pretreatment *Careful pretreatment is necessary to obtain good adhesion. Note how initial application of chemical conversion coating extends wear life.*



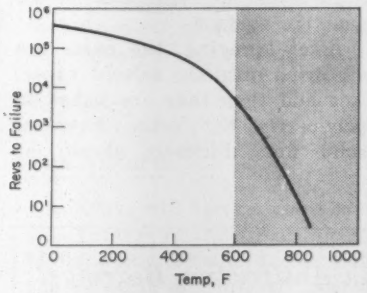
Speed *Life increases with increasing surface speed up to 30 fpm. Above this value film life begins to decrease because the higher speeds generate heat and cause the binder to decompose.*



Load *Life increases with increasing load because of the lower coefficient of friction under higher loads—up to a point. Low bearing pressures (below 20,000 psi) result in a higher coefficient of friction and correspondingly higher temperatures and degradation.*

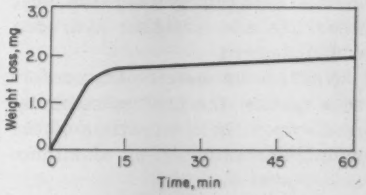


Lubricant content *This, and the previous diagram, bear out the rule that increasing the solids-to-resin content will increase film life. However, cutting the resin back too far will cause high speed shearing and fast deterioration of the film.*

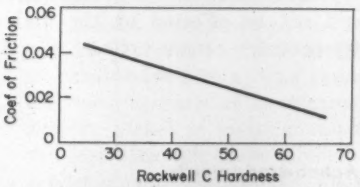


Temperature *Rapid drop in wear life shown here is caused by the softening of the bonding agent with increasing temperature.*

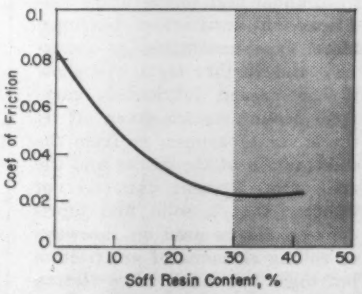
WEAR . . .



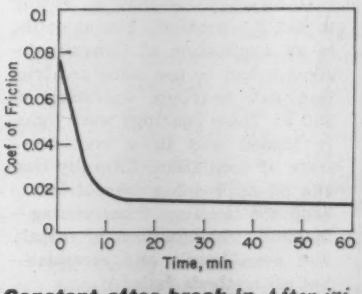
Constant after break-in *Once the bonded lubricant film has had a chance to break in, wear loss will occur at a constant, low rate. Initial loss is primarily due to film compression, not shearing away.*



Metal hardness *Friction decreases as metal hardness increases due to the rigid support provided by harder metal.*



Film hardness *Soft resin content up to about 30% tends to lower the coefficient of friction. Above this value the curve begins to flatten out.*



Constant after break-in *After initial alignment of the molybdenum disulfide particles, the bonded film develops a virtually consistent, low coefficient of friction.*

shows that a 12.5% (±0.3%) phosphate solution with an iron content of 0.2% produces a satisfactory buildup of 0.15 mil when the part is immersed for 15 min. Although visual bubbles stop appearing after 5 to 7 min, bonding still occurs after this period.

The wear life of the solid film lubricant is strongly affected by the thickness of the manganese iron phosphate coating and its crystal pattern. In general, a finer crystal pattern makes for better corrosion protection and a longer wear life. A fine crystal pattern is obtained with the pretreatment described below. Unfortunately, however, these procedures cannot be used on certain high strength steels because of the danger of hydrogen embrittlement. Because of insufficient experience with this problem a compromise has to be made on some metals between getting the best wear life and avoiding hydrogen embrittlement.

Nonferrous metals—On nonferrous metals, the pretreatment depends upon the composition of the metal. For example, on aluminum and its alloys we use a chemical film treatment such as anodizing to provide a satisfactory base for the lubricant. On magnesium and its alloys the dichromate treatment per Mil-M-3171A Type II or III has proven best. No chemical pretreatment is necessary on titanium. Pretreatment for nonmetallics also vary considerably. Materials such as plastics and rubber are usually cleaned with a compatible cleaner followed by soft grit blasting using cracked barley, crushed corn cobs, ground walnut hull or similar media.

How to apply the solid film

Ordinarily solid film molybdenum disulfide lubricants are applied over the phosphated surface by spraying. Brushing or dipping can be used under certain circumstances but spraying is usually best because it permits best control of coating thickness.

A high degree of operator skill is required. If the coating dries before it hits the part it will have poor adherence. Conversely, if it is too wet it may develop runs or cause a concentration of solids too near the surface.

After spraying, the parts are air dried until the solvent vaporizes and then they are baked to polymerize the resin. Eventual solid film thickness should be from 0.2 to 0.5 mil. Much data exists to show that coatings thinner than 0.2 mil have short wear life due to insufficient lubricating solids (see box), and that coatings over 0.6 mil are structurally weak and tend to crumble under load. It is obvious that the coatings cannot be used to build up undersize parts

Wear life and corrosion protection can be greatly increased by coating both mating surfaces. If the surfaces have about equal bearing area then the wear life of two coated surfaces will be roughly three times that of a single coated surface. It is recommended that when only a single surface is to be coated, the larger of the two surfaces should be coated. Also, when two surfaces of different hardness are involved, always coat the harder of the two.

Maximum curing temperature varies with individual manufacturers but is usually about 375 F for 1 hr on low alloy steels. Some high performance coatings may require as long as 14 hr cure time. For example, one high temperature (900 F) coating developed by Convair (Convair's FMS-0112) requires a baking cure of 4 hr at 500 F. Naturally, this coating is limited to materials that will not be affected by the high temperature curing cycle.

Use Solid Film Lubricants on Antifriction Bearings?

It is generally accepted that solid film lubricants should not be used on antifriction bearings. Assuming that the raceways or rolling elements are coated, this conclusion is attributed to the fact that shearing of the lubricating particles may interfere with the action of the rolling elements in the raceways.

However, there may be a way to lick the problem. For example, in an application at Convair, designers had to use some antifriction ball bearings operating at 900 F. These bearings were lightly loaded and in a continuous state of oscillation. Literally dozens of approaches were tried to keep the bearings from seizing—including combinations of metals, and even jewels and ceramics—but all methods failed.

Finally, a completely new approach was tried. The bearing separators were first copper plated, then silver plated, and finally coated with Convair's solid film high temperature lubricant (described in text). In the next series of tests all of the bearings passed the test without a seizure.

Naturally, on the basis of this one series of tests the use of a solid film lubricant cannot be justified under high temperature conditions on antifriction bearings. More experimentation is necessary and further tests will show if the needed lubrication came from certain oxides given off by the silver or copper, or from the combination of the oxides and the solid film. Present data do not indicate that a solid film lubricant should be used on raceways or rolling elements of antifriction bearings, but much more testing of the film on separators or cages is certainly warranted.

Acknowledgments

In addition to the Convair Engineering Chemical Laboratory, the author wishes to acknowledge the assistance of the following companies in obtaining some of the data presented:

Almasol Corp.
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Bemol, Inc.
Champion Products, Inc.
Hohman Plating Co.

High Temperature Materials Today and Tomorrow

A summary of five recent AIME papers on the present and future of refractory metals, alloys and compounds.

■ The materials to be discussed here are presently of interest chiefly to the aircraft and aerospace industries. But raising the temperature limits of engineering materials is becoming increasingly important to many industries. In the long run the kind of progress reported here will allow the electrical industry to generate power more efficiently, perhaps open new vistas in transportation, and increase the efficiency of the chemical process industries, to cite only three examples.

Here is a summary of what five experts believe these high temperature materials can do now and what you can expect from them in the future.

1. Cobalt and nickel-base alloys

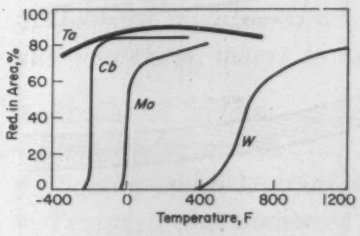
During the past 20 years the temperature capability of nickel-base alloys has increased more than 300° F while cobalt-base alloys have gained approximately 150° F, measured in terms of 100-hr rupture life at 18,000 psi. About 25 significant nickel-base alloys have been developed in the last 20 years in contrast to only 10 cobalt-base alloys. The reason for these disparities is relatively simple: nickel is more abundant and less strategic than cobalt.

Nickel and cobalt-base alloys develop their high temperature strength in different ways. High temperature nickel alloys are strengthened by the compound $Ni_3Al(Ti)$; the more present in the matrix, the greater the rupture strength. As service temperatures increase, however, the compound goes into solution and the alloys lose strength rapidly. Cobalt alloys on the other hand, are strengthened by refractory metal carbides which go into solution slowly and provide strength at higher temperatures than can be achieved by the nickel-base alloys. Cobalt-base alloys can be used at temperatures above 1900 F, and the sluggishness of the carbide reaction, coupled with the higher melting point of cobalt, will lead to improved high temperature capabilities in the next five to ten years.

The future

▸ Alloys will become more complex because of the trend to combining many elements rather than adding large amounts of individual elements. Melting problems will become more critical as complexity of alloys increases.

▸ Vacuum melting and vacuum arc remelting will become increasingly important to maintain control of additions as well as to promote homogeneity as alloys become more complex.



1—Effect of temperature on the tensile ductility of columbium, molybdenum, tantalum and tungsten. Ductility was determined on recrystallized metals.

▸ The accent will be on casting alloys because of their superior rupture strength above the equicohesive temperature.

▸ Dispersion-strengthened cobalt and nickel-base alloys will assume increased importance because of their improved structural stability at high temperatures.

2. Tantalum, tungsten and their alloys

Tantalum and tungsten have the highest melting points of all the structurally available metals. While tantalum has not always been considered competitive as a high temperature material, its low temperature ductility, shown in Fig 1, is an important asset. Also important: this low temperature ductility is retained when tantalum is alloyed to improve its hot strength.

In the past, powder metallurgy techniques have been the principal means available for consolidating tungsten and tantalum products. These techniques are still important, but consumable electrode and electron beam melting techniques can be expected to assume increasingly important roles as the need for large tantalum or tungsten parts develops.

To date, only about 12 tantalum alloys have been made in ingot diameters above 2 in. using consumable electrode melting. These include Ta-(10, 20, and 30)W, Ta-30Cb-7.5V, Ta-10Hf, Ta-10Hf-5W, Ta-8Hf-8W, and Ta-4Hf-4W, as well as two proprietary modifications of the Ta-10W alloy. Of these alloys, only Ta-10W is now commercially available.

Although electron beam melting can be used to produce tungsten alloys, powder metallurgy techniques are required to produce the

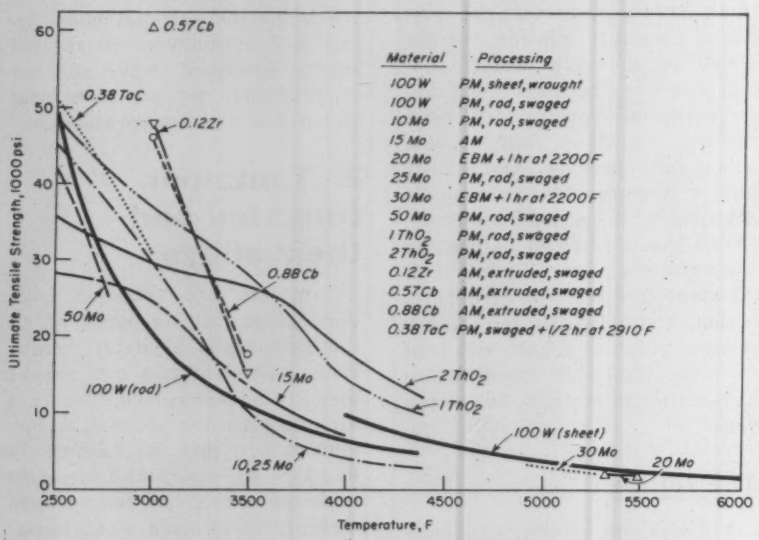
thoriated grades, the only alloys that have a significant strength advantage over unalloyed tungsten above 4000 F. Fig 2 summarizes most of the available elevated temperature tensile strength data for tungsten alloys.

The future

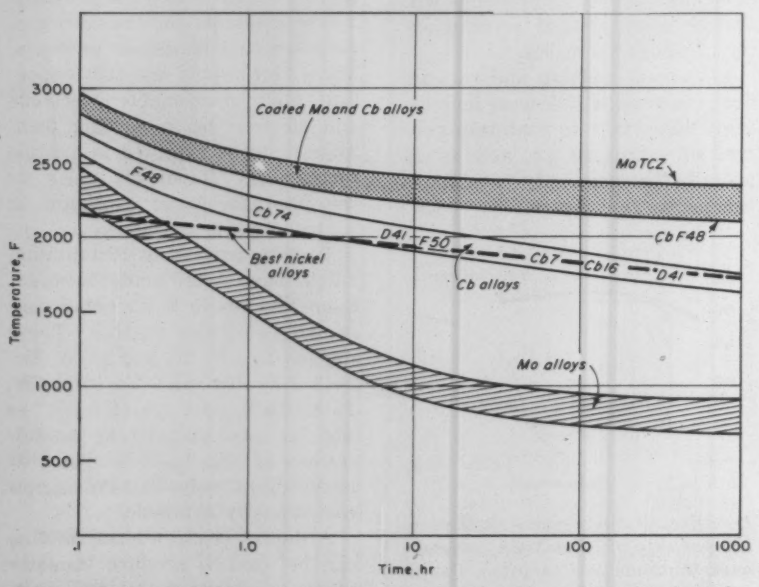
▸ Tantalum-base alloys will probably not be competitive with columbium or molybdenum-base alloys below 2500 F. The greatest promise for applications lies in the range 2500 to 3000 F where they offer outstanding strength and both good formability and good weldability.

▸ Solid - solution - strengthened tungsten alloys such as W-15Mo should find applications as forgings or sheet between 2500 and 4000 F. Above 4000 F, diluted tungsten alloys such as W-$ZThO_2$ will offer the greatest strengths.

▸ It is believed that a tungsten alloy which is ductile at room temperature can be developed by proper alloy additions and control of grain size.



2—*Effect of temperature on the tensile strength of tungsten alloys.* PM *indicates a powder metal product,* EBM *an electron beam melted product, and* AM *a consumable electrode arc melted product.*



3—*Structural capabilities of molybdenum and columbium alloys in air under 20,000 psi stress.*

3. Molybdenum and columbium alloys

Structural capabilities of currently available columbium and molybdenum alloys in air under 20,000 psi tensile stress are shown in Fig 3. Oxidation rates of the molybdenum alloys are so high that appreciable times under stress cannot be maintained over 1000 F. It is apparent, however, that the columbium alloys are able to sustain 20,000 psi for longer times at considerably higher temperatures. The uncoated columbium alloys, in fact, are equal to the best cast nickel alloys, and significantly superior to the nickel alloys when exposed for less than 10 hr.

A major problem in both alloy systems is the lack of oxidation resistance. Molybdenum and its alloys show very high metal loss rates above 2000 F, while the columbium alloys range in loss rates from one which is almost as bad as that of the molybdenum alloys to a rate which is almost competitive with that of Inconels and Nichromes. On the other hand, columbium and its alloys are contaminated more rapidly by dissolved oxygen than either the nickel or molybdenum-base alloys.

The future

There are at least five exciting paths that can be investigated in mapping out the potential of columbium and molybdenum alloys:

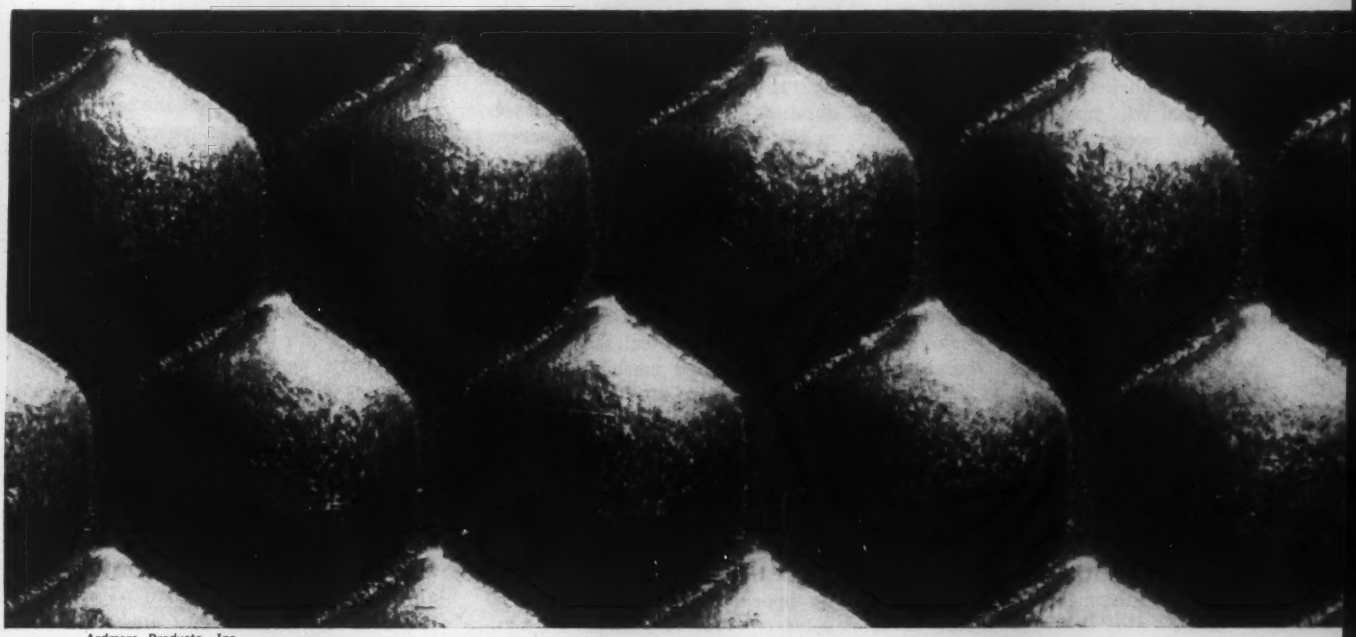
▸ Mixed molybdenum-columbium-tantalum - tungsten - base alloys. This is a little-explored area and the entire quatenary field must still be mapped out.

▸ Control of interstitial elements such as carbon and oxygen. At present, these elements cannot be controlled, their amounts can-

(continued on p 145)

M/DE Manual No. **186** *August, 1961*

An Up-to-Date Look at Prefinished Metals



Ardmore Products, Inc.

Want to use a sheet metal that requires no finishing after fabrication? Here is an easy-to-use summary of all major prefinished metals . . . what they offer, how to fabricate and join them, where to use them. Included are:

- *Preplated metals*
- *Prepainted metals*
- *Plastics-metal laminates*
- *Textured and embossed metals*
- *Hot dipped metals*
- *Special prefinished aluminum*

by Robert J. Fabian, *Associate Editor, Materials in Design Engineering*

■ Strictly speaking, every metal that you buy is prefinished—it is probably finished at the mill in one way or another. However, some metals are treated more than others and in this article the term prefinished metals is intended to encompass all sheet metals that are precoated or treated at the mill so as to eliminate or minimize final finishing by the user. In short, those metals that come to you ready-to-use with a decorative and/or functional finish.

The number and variety of prefinished metals that have been developed in recent years is truly astounding. Just take a quick look at the products around you and you will probably find at least one or two. In all probability these products were previously finished after fabrication; however, the change was made to secure decorative, economic or functional advantages.

You can now obtain base metals preplated with almost any decorative or functional metal, from bright, shiny chromium to dull, rich-looking brass. Similarly, you can obtain sheet with prepainted surfaces in almost every color and in a wide variety of special-purpose plastics resins. If you need extra durability or a special decorative effect some of these resins, notably polyvinyl chloride, are available in sheet or film, laminated to the metal of your choice.

If you would like something more decorative (and stronger) than plain metal, you can now obtain almost every metal in a limitless number of textured, patterned and embossed finishes right from the mill. These textured metals can be used as-is, but even they can be supplied preplated, prepainted, or even with a colored pre-anodized finish, as in the case of aluminum.

Finally, if your requirements are mostly functional, do not overlook the many sheet metals that are available with galvanized, aluminized, tin and terne coatings. These materials, especially galvanized, were among the first prefinished metals to be developed and remain today as basic "workhorse" prefinished metals.

Why use prefinished metals?

Prefinished metals provide many advantages and it is difficult to single out any one dominant selection factor. As the following analysis shows, you can use them to . . .

Enhance product appearance

Actually, in many cases appearance alone is not the dominant selection factor. In the case of preplated and prepainted metals the user is usually seeking good appearance *plus* something else such as lower cost, easier fabrication, or greater product uniformity. If appearance alone were the dominant selection factor then you might as well plate or paint the part after fabrication. Except for uniformity, a plain plated or painted surface looks the same whether it is made of prefinished metal or finished after fabrication.

Of course this does not apply to brushed or textured effects. Many preplated metals can be obtained with a brushed mechanical finish over the entire surface, or in the form of stripes. Such effects are costly and in many cases impossible to apply after fabrication. Similarly, heavy prepainted coatings can be mechanically embossed with a variety of patterns.

Plastic-metal laminates are in an appearance class all by themselves. Vinyl (PVC)–metal laminates can be produced in just about every pattern, texture and color that can be thought of. Textile effects, wood grains and leather surfaces have all been closely duplicated. Outside of using the real material, many of these effects cannot be duplicated on metal by any other method except in plastics laminates. Designers are devising new patterns and textures every day and if you have a special one in mind you can probably obtain it on special order.

Textured, patterned and embossed metals also provide a unique appearance. In almost all cases it is impossible to obtain these effects after fabrication. Here again, appearance possibilities are unlimited and custom patterns (see photo of auto rear deck trim) can be obtained by having special embossing dies made (economical only if large quantities are needed).

Except for galvanized sheet, the conventional hot dipped and electroplated sheets such as aluminized, tin and terne plate are not ordinarily used for decorative reasons. The appearance of galvanized metal is familiar to us all (garbage pails, gutters, etc.) and, although it is not as pleasing as glamor electroplates such as chromium and nickel for some applications, it is quite satisfactory for many functional products.

Lower product cost

Prefinished sheet is not the ultimate answer for lowering production costs, as borne out by the fact that most electroplated and painted parts made today still are finished after fabrication. Prefinished metals—notably preplated and prepainted—are most effective in lowering the cost of mass produced small parts. Small sheet metal parts can be relatively expensive to electroplate or paint in large quantities.

No specific recommendations can be given because each product and shop is different. The only way you can determine comparative costs is to: 1) total up your finishing costs and metal costs, and 2) compare this figure with the cost of an equivalent amount of prefinished metal. You should also figure that the scrap loss of prefinished metal is higher than that of unfinished metal. Fabrication costs can usually be ignored because in most cases it does not cost any more to fabricate prefinished metal than unfinished metal.

An important benefit of using preplated and prepainted metal is that it can enable smaller shops to completely eliminate the need for maintaining a plating or painting department. Of course this applies only where you are dealing exclusively with prefinished materials in your products.

Obtain greater uniformity

One of the most striking things about prefinished metals is their high uniformity. This uniformity is obtainable because the coatings are machine-applied under constantly controlled conditions. This does not mean too much from an appearance standpoint as most consumers would be hard pressed to tell the difference between a prefinished surface and a surface coated by ordinary methods. The only difference that might be apparent is that the coating on prefinished metal products does not have any tendency to build up at bends and corners.

The greater uniformity of prefinished metals can be of greater benefit in functional applications, especially where an electroplate of constant thickness is needed. As is well known, electroplates tend to build up on high spots and thin out in low areas; this can cause problems where good corrosion and wear resistance is needed. Preplated metals are plated when flat and thus uniformly.

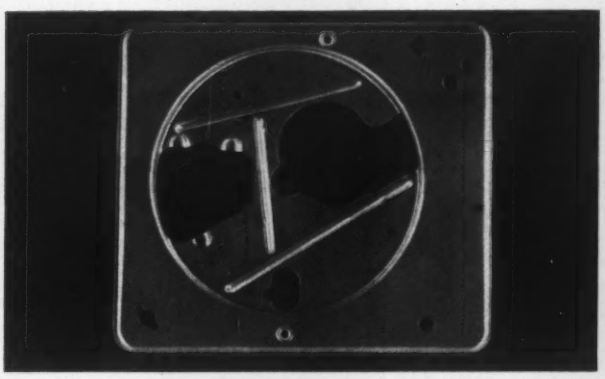
Improve product function

A large amount of prefinished metals is used for functional applications. This may be surprising as many people tend to associate preplated and prepainted metals chiefly with decorative uses.

Practically all zinc-plated sheet, for example, is used in functional applications where good corrosion resistance, rather than a bright,

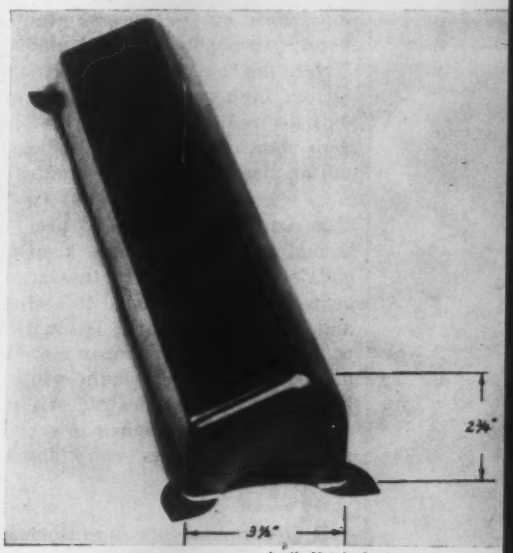
Four summary tables follow; text continues on p 139

Preplated Metals Can Withstand Severe Forming



Apollo Metals, Inc.

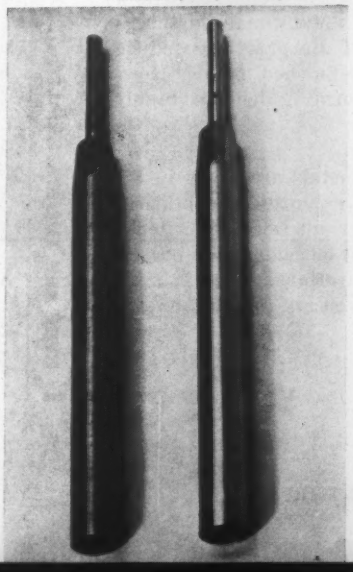
Phonograph turntable *plate 0.062 in. thick is carried through six die operations without a blemish. In addition, four springs, three studs and three bolts are welded to steel back without any suggestion of weld marks on surface. Finish is chromium plate over 0.5 mil of satin-finished nickel.*



Apollo Metals, Inc.

Escutcheon plate *shows uniform satin finish along top, sides and corners after severe forming. Coating system consists of 0.3 mil copper, 0.3 mil nickel and 0.005 mil chromium over steel. Surface is protected with special paper to prevent marring during forming.*

Thomas Strip Div., Pittsburgh Steel Co.



Small barrels *of nickel and brass-plated steel are typical of draws that can be made. Use of fine grained metals and intermediate annealing permits very deep draws.*

How to Use the 4 Tables

This article has been especially designed as an easy-to-use reference built around the following four tables which contain basic data on all important prefinished metals. The tables are laid out so that you can compare one material with another and decide which material(s) looks most suitable for your application.

1 *Types, properties and applications* of all important prefinished metals are described in the first table. Probably the most striking conclusion to be drawn from this side-by-side comparison is that you can obtain prefinished metals in just about any color, texture, finish or combination that you desire. In fact, if the appearance or surface you want is not available in prefinished metal, it probably is not available in any form.

Note too that you can obtain almost any end property you need —from high strength to high corrosion resistance—by mating your desired finish to the right base metal. The diverse applications shown in the right-hand column attest to the wide range of end application conditions that you can meet.

2 *Available sizes* of all prefinished metals are shown in the second table. You should keep in mind that not all prefinished metals are available in the large size sheets and coils that we have become accustomed to seeing. Some fancy-patterned copper and brass, for example, is available in a maximum width of less than one inch. Remember also that the values shown are maximums, and the maximum width that can be supplied depends largely on the gage desired. All in all, however, prefinished metals can generally be supplied in very large sheets and coils, and sizes are becoming larger every day to accommodate special end-use requirements.

3 *Design and forming* information for these materials is given in the third table. You will note in this table that one very important fact keeps repeating: in order to preserve surface appearance during forming you must observe good die practice and keep your dies clean and properly dressed. Many manufacturers maintain that no more than normal good die practice need be observed. This is essential for ordinary prefinished metals. However, special care will be required when forming delicate, highly finished surfaces.

4 *Joining and fastening* data for the metals are given in the last table. Note that some materials have limited capabilities; thus, joining and fastening can be an important selection criteria. For example, most prepainted metals cannot be soldered or brazed, and some metals have severe welding limitations. Keep in mind that this is a pre-selection guide only. If you are in doubt on any score, check with the materials supplier.

1 HERE ARE THE MATERIALS . . . THEIR PROPERTIES AND THEIR USES

MATERIAL →	Surface Composition, Appearance	Base Metal	Important Properties	Typical Uses
PREPLATED METALS	NICKEL, CHROMIUM Excellent appearance; available in dull, satin and bright (sometimes provided with a clear lacquer coating for added protection) finishes, many of which can be embossed with wide range of patterns.	Steel	High strength plus low cost.	**Nickel or chromium plate:** Toys, brush ferrules, appliances, display stands, reflectors, stove and heater parts, housewares, hardware and trim. **Nickel plate:** Radio tube parts, looseleaf binders, battery shells, mercury cell cases, locks, candy molds.
		Zinc	Low cost, corrosion resistance, good flexibility and workability.	Tube clips, buttons, caps, badges and emblems, moldings, trim, display signs, auto accessories, miniature letters, louvers and grilles.
		Brass	High corrosion resistance and durability, good workability; can be tempered.	Fish lures, trim, nameplates, mirror backs, trophies, emblems, lighting and fireplace fixtures, door and lock hardware, clock hands and parts.
		Copper	Good corrosion resistance and workability.	Electrical devices, signs and reflectors, and many of same applications as brass-base.
		Aluminum	Light weight and corrosion resistance.	Lighting fixtures, stove parts, nameplates, appliance parts, reflectors, trim.

	BRASS, COPPER Excellent appearance; available in dull, satin and highly polished finishes, many of which can be embossed with wide range of patterns.	Steel Zinc	High strength plus low cost. Good flexibility and workability.	**Copper or brass:** Lamp trim, luggage hardware, jewelry and handbag parts, display stands, lampshades and light fixture parts, wall clocks, coasters, tissue dispensers, curtain rods. **Copper:** Flashlight cases, variable resistor housings, spray can housings (copper helps low temperature tinning and high temperature brazing), auto gaskets. **Brass:** Casket handle tubing (can be given an antique finish), brush ferrules, lipstick cases (has good drawing properties). Inlays, ornaments, badges, moldings, jewelry, buttons, trim.
	ZINC Natural grayish finish which can be used to improve product appearance by providing with semi-lustrous finish and coating with clear lacquer.	Steel	Popular as an inexpensive pre-coat for subsequent finishing. Can be phosphate or chromate treated to improve paint adhesion.	Metal hose (for corrosion resistance), door locks (hidden parts, as in car locks), brush bristle holders, condenser housings, tags, vacuum sweeper and telephone parts, cabinet hardware.
PREPAINTED METALS	Almost every organic coating is available or can be ordered in prepainted form. Selection of coating resin depends on end use requirements. Five most popular prepainted metals now in use are alkyds, acrylics, vinyls, epoxies and epoxy-phenolics. Many coatings can be pigmented to provide metal-like appearance.	Most common ferrous and non ferrous metals. For added protection reverse side of ferrous metals is usually given a rust preventive treatment or provided with an organic or metallic coating. Selection of base metal depends on cost, appearance and product life requirements. Most popular base metals are: cold rolled steel, tinplate, tin mill blackplate, hot dipped and electrogalvanized steel, and standard aluminum alloys.	Properties depend largely on type of resin used. Selection of best resin is usually decided by discussing requirements with supplier. Important characteristics of five common types are: Alkyds—Low cost, good color retention, good general purpose properties. Acrylics—Good resistance to outdoor exposure. Vinyls—Tough, good resistance to abrasion (especially where heavy forming is required), good resistance to water and outdoor exposure. Epoxies—Excellent adhesion and resistance to chemicals, food products. Epoxy-Phenolics—Good resistance to corrosion. All coatings can be supplied in a wide variety of colors and in dull, semi-gloss or gloss finishes. Heavy vinyl coatings are available in many textured patterns (similar to vinyl-metal laminates) which are embossed into coatings.	**Appliances:** Mostly interior parts. Some users are obtaining excellent finish by specifying prepainted material, then coating with conventional topcoat (as general rule, base coating provides excellent adhesion for subsequent topcoats, especially for vinyl organosol or plastisol coatings). **Automotive:** Oil filter cartridges, windowframe trim, instrument panel and voltage regulator covers, rocker arm covers (experimental), odd clips and brackets. **Furniture:** TV trays, (epoxy-phenolic has good alcohol resistance), round legs, various metal furniture components. **Building and construction:** Hot water heater parts, baseboard convection heater covers, trim, gutters, window screens and storm window frames. **Miscellaneous:** Toys, cabinets (especially with wood grain finish), interior shelving.
PLASTIC-METAL LAMINATES	**VINYL (PVC)-METAL** Polyvinyl chloride sheet laminated to base metal with thermosetting adhesives under heat and pressure (25 to 60 psi).	Can be applied to most metals; popular are: Steel—Provides strength at low cost. Reverse side can be painted or provided with corrosion resistant coating. Aluminum—Light weight and/or corrosion resistance. Magnesium—Light weight.	**Appearance:** Available in an unlimited number of colors and surface textures. Typical textures include leathers (which except for smell are almost indistinguishable from real leather), textiles, wood grains, marbleized high gloss, and nonreflecting matte. Indoor color retention excellent; outdoor color retention should be checked with manufacturer or by testing. **Moisture and weather resistance:** Excellent, as attested by fact that laminates now used in many outdoor applications, even for building exteriors. **Chemical and stain resistance:** Resists most common materials including: water, coffee, milk, bourbon, hot bacon grease, mineral oil, Coca Cola, petroleum, ketchup, citric acid, Clorox, ammonia, animal and vegetable oils, chromic acid, and orange, lemon and banana peel. Some staining may occur with vinegar, spinach, red food dye and mustard. Exposed metal edges can be easily painted but do not generally present corrosion problems. Keep laminates away from chlorinated solvents. **Abrasion and wear resistance:** Wear tests using Taber abrader (CS-10 wheel) show that it takes over 2000 rev to wear through 1 mil of vinyl sheet. Luggage and appliance applications attest to ruggedness. **Heat resistance:** Moderate, about 195 F max.	Wide range of appearance and/or functional uses including: TV and radio cabinets, home appliance exteriors, luggage, aircraft panels (Boeing 707), auto trim (Thunderbird), bus interiors, construction panels, showcases and fixtures, cameras and projectors, toys, cabinets, tables and other furniture.
	VINYL (PVF)-METAL Polyvinyl fluoride film laminated to base metal with thermosetting adhesive under heat and pressure.	Cold rolled steel—Provides strength at low cost. Galvanized, aluminized and tin-plated steel—Corrosion resistance. Aluminum—Light weight and corrosion resistance.	Smooth, nontextured surface available clear or pigmented. Because of newness, colors are limited to white, gray and green. Excellent weatherability, high resistance to sunlight degradation, not affected by many common solvents including hydrocarbons and chlorinated solvents. Impermeable to greases and oils.	Designed to compete more with conventional painted metal than with other vinyl-metal laminates. Although it can be used for housings, cabinets, tables, etc., current use is directed toward outdoor applications such as building siding, billboards, prefabricated panels, ductwork, roofing and gutters.

(This table continues on next page)

1 HERE ARE THE MATERIALS . . . THEIR PROPERTIES AND THEIR USES (Continued)

MATERIAL ↓	Surface Composition, Appearance	Base Metal	Important Properties	Typical Uses
PLASTIC-METAL LAMINATES (Continued)	POLYESTER-METAL Polyester film laminated to base metal.	Usually steel.	**Appearance:** Smooth, glossy finish available in a wide variety of solid colors (white is popular). Can also be produced in a wide variety of photographed patterns, notably simulated wood finishes. **Moisture resistance:** Not affected after 1000-hr exposure to 97% RH at 100 F. Other tests show that laminate holds up well after 115-hr immersion in water at 77 F, and after 1-hr exposure to steam. **Chemical and stain resistance:** Unaffected by citric acid (10%), mustard, vinegar, coffee, cooking oil, beet and lemon juice, ammonia, ink, iodine, Clorox, soap and detergents. **Abrasion and wear resistance:** Will withstand 1500 cycles of a CS-17 F wheel (1000 gm).	Biggest application to date has been stamped wood-grained TV cabinet. Suggested applications include housings for movie and slide projectors, vending machines and tape recorders. Also, roof linings for trucks and buses, wastebaskets, bread boxes and food trays.
TEXTURED AND EMBOSSED METALS	Surfaces available in hundreds of different textures and patterns. Available with texture on one surface only or with pattern that extends completely through cross section of metal. Also available in perforated form. Surfaces can be provided with dull satin or highly polished finish or combinations thereof (e.g., dull background with polished highlights). Can also be painted, porcelain enameled, or oxidized; these finishes can be buffed off high spots to provide two-tone effect.	All common sheet metals, including: Carbon steel—Strength at low cost. Stainless steel—Corrosion resistance plus strength. Aluminum—Light weight plus corrosion resistance. Copper—Pleasing appearance plus high strength and corrosion resistance.	**Appearance:** Limitless possibilities. **Weather and chemical resistance:** Base metal can be selected to resist almost any outdoor environment, chemical or stain. **Abrasion and wear resistance:** Better than prepainted metals. Because of texture, surfaces are less liable to show scratches and mars than prepainted metals.	Applications limited only by imagination of designer. **Transportation:** Flooring, wainscotting, paneling, trim, instrument panels, seat backs and kick plates. **Appliances:** Stove hoods, grilles (perforated), housings, evaporator wrappers, trim and face plates. **Building and construction:** Acoustical backdrops and ceilings, curtain walls, interior and exterior panels, siding, window spandrels, elevator interiors. **Miscellaneous:** Furniture, store checkout counters, utensil racks, wastebaskets, signs, soda fountain equipment, commercial refrigerators and showcases.
HOT DIPPED OTHER PLATED METALS	GALVANIZED (ZINC-COATED) Zinc surface with intermediate zinc-iron alloy layer.	Steel, ingot iron.	High corrosion resistance, low cost, good strength and formability.	**Agricultural:** Hoppers, bins, tubing, housings, trays, silos, tanks. **Appliances:** Clothes dryer drums, radio chassis, coil plates, rinse tubs. **Automotive:** Radiator shells, scuff plates, air filters, rocker panels, floor side members, front rail extensions. **Miscellaneous:** Boat hulls, gasoline cans, ash cans, barrels, snow shovels, playground slides, boxcar panels and trusses, meter boxes, pole line hardware, switch boxes and covers.
	ALUMINIZED Aluminum surface. Intermediate aluminum-iron alloy layer forms above 900 F.	Steel.	High resistance to corrosion, good strength, high heat resistance, good heat reflectivity.	Popular for heating applications such as: dryers, firewalls, auto mufflers and tailpipes, barbecue grilles, furnace combustion chambers and casings, numerous components for ovens, ranges, water and space heaters, toasters.
	TIN-COATED Hot dipped or electroplated tin.	Mild carbon steel.	Low cost plus good strength and corrosion resistance.	Food product containers.
	TERNE OR LEAD-COATED Lead-tin alloys, pure lead.	Steel.	High corrosion resistance and strength, relatively low cost (same range as galvanized), plus good solderability and drawability.	Gasoline tanks, electrical chassis, condenser cans, battery boxes, heater assemblies, chemical processing equipment, hardware, roofing, ductwork, various sheet metal parts.
SPECIALLY FINISHED ALUMINUM	COLOR ANODIZED Anodized aluminum available in clear, yellow gold (70:30 brass) red gold, rich low brass (85:15 brass), copper, blue, green, red and black. Colors are obtainable over standard mill, satin and bright finishes, as well as over embossed and perforated textures.	All commercial aluminum alloys and tempers.	Excellent appearance, uniform and durable color, high corrosion resistance, light weight.	Nameplates, wall tile, knob inserts, decorative trim, moldings, button shells.
	SPANGLED Uncoated surface containing large grains which stand out in relief and facets which break up and reflect light. Available in wide variety of colors and mill finishes.	Wrought aluminum alloys.	Unusual appearance, light weight, corrosion resistance.	Automotive and appliance trim, lighting fixtures, jewelry and novelty items, giftware.

2 YOU CAN OBTAIN THEM IN THESE TYPICAL SIZES

MATERIAL ↓	Thickness	Width	Length
PREPLATED METALS	Varies with metal-metal combination. Thicknesses up to 0.125 in. are obtainable.	**Sheet:** Most materials available up to 36 in.; however, some can only be obtained as wide as 12 in. **Coil:** Varies with manufacturer and materials; 22.5-in. max is typical.	**Sheet:** 96 in. **Coil:** Any.
PREPAINTED METALS	**Coating:** Normally about 1 mil but can range from as low as 0.2 mil up to 20 mils (vinyl plastisols). **Base metal:** Roughly 0.007 to 0.065 in. Heavier gages may not be available in wide sizes.	Up to 66 in.	**Sheet:** About 8 ft. **Coil:** Any length.
PLASTIC-METAL LAMINATES	VINYL (PVC)-METAL **Steel:** 0.012-0.06 in. Aluminum: 0.016-0.125 in. Magnesium: 0.016-0.081 in. Depending on application, vinyl sheet can be specified from 4 to 25 mils; 10 to 15 mils is usually sufficient.	**Sheet:** As high as 50 in., but usually from 40 to 48 in., depending on base metal. **Coil:** About 40 in.	**Sheet:** As high as 144 in., but usually 60 to 96 in. **Coil:** Any.
	VINYL (PVF)-METAL Recommended film thickness is 2 to 3 mils. Total thickness of steel laminates: cold rolled, 0.012-0.0598 in.; galvanized, 0.0149-0.0516 in.; aluminized, 0.0186-0.0430 in.; tinplate, 0.0149-0.0239 in. Thickness of aluminum laminates: 0.015-0.063 in.	50 in. max except for tin-plated steel which is available to 34.5 in.	About same as above.
	POLYESTER-METAL Film is 2 mils thick. Total thickness roughly same as above.	48 in.	Unlimited (continuous coil).
TEXTURED AND EMBOSSED METALS	Roughly 0.008-0.093 in. In general, available in all standard sheet gages, depending on pattern.	Fraction of inch up to 52 in., depending on pattern.	**Strip:** Roughly 8 ft. **Coil:** Unlimited.
HOT DIPPED, OTHER PLATED METALS	GALVANIZED (ZINC-COATED) 0.018-0.0785 in.	To 50 in., depending on gage.	**Sheet:** Any reasonable length. **Coil:** Any.
	ALUMINIZED 0.0155-0.1124 in.	To 48 in., depending on gage.	**Sheet:** To 150 in. **Coil:** Any.
	TIN-COATED Usually 0.008 to 0.015 in.	About 20 by 30 in.	
	TERNE OR LEAD COATED Roughly same as galvanized.		
SPECIALLY FINISHED ALUMINUM	COLOR ANODIZED 0.002-0.04 in. (0.015 in. min for sheet).	**Sheet:** 12-48 in. **Coil:** 0.375-24 in.	**Sheet:** 20-180 in. **Coil:** Any.
	SPANGLED 0.032-0.1 in.	36 in.	96 in.

3 HOW TO DESIGN AND FORM PREFINISHED METALS

MATERIAL ↓	Protecting During Forming	Punching, Shearing	Bending	Stamping	Drawing
PREPLATED METALS	Except when light forming dull or satin finishes, protection usually required. Sheet or coil can be supplied with coating. Ordinary paper often not suitable, can mar material. Special pressure sensitive papers good but add to cost. Some lubricants such as oils and wax-base materials will prevent abrasion marking during forming; however they may have to be removed with hot water or cleaner. Inexpensive vinyl coatings now under development.	If dies are in good condition, can be handled like ordinary sheet metal. No extra die clearances needed. Copper and brass coatings are easy on dies; nickel and chromium, being harder, may cause dies to wear more quickly.	Limitations usually depend on base metal. Coatings rarely fail and can usually take any bend that base metal can; failure of coating is usually caused by failure of base metal. Limitations must usually be determined by cut-and-try process. Dulling at bends is often not apparent to user, but if necessary can be minimized by using special steels (such as aluminum-killed) with uniform grain structure. One supplier recommends bend radius at least 3 times metal thickness with 180-deg bend and a min ¼-in. radius on 0.036 to 0.062-in. metal. In general, as radius is reduced, coating thickness must be increased.		No hard and fast rules. As photos in article show, extremely deep draws can be obtained (particularly with nickel, copper or brass-coated steel) by using fine-grained steels and by annealing between draws.
PREPAINTED METALS	Normally, no protection required. However, extra care required in handling and transferring materials to insure that sharp edges, chips and dirt do not mar finish. When using die lubricants check compatibility of lubricant with coating; some lubricants can destroy appearance and properties. Dry lubricating waxes cause few problems. Some lubricants may have to be removed after forming; in some cases problems can be minimized by incorporating lubricant into coating (this is a frequent request).	Same as above.	Provided dies are in good condition and properly dressed, coated metals generally withstand any bending operation that base metal will. If coating flakes or cracks this is invariably caused by cracking of base metal. Problem can be minimized by using base metal that is more amenable to bending, by using a heavier coating, or by adjusting coating formulation for better flexibility (vinyls are especially noted for flexibility).	Provided that dies are in good condition, almost all stamping operations can be performed without marring. In some cases paint can actually protect die.	No hard and fast rules but, in general, coated metals can be drawn almost like uncoated metals. Die marks may appear but usually can be avoided by cleaning and dressing dies. Draws up to 3 in. deep have been formed in one operation without surface damage.
PLASTIC-METAL LAMINATES	VINYL (PVC)-METAL No protection required during forming; can be handled like ordinary sheet metal. It is possible to score vinyl; however, this can be avoided by using good clean dies and allowing adequate die clearance.	Can withstand normal cutting and shearing. Wherever possible, vinyl side should be toward cutting edge.	Because vinyl has more elasticity than base metal it can be bent and formed to any shape that base metal will withstand. Be sure to allow for thickness of vinyl—can be compressed to 60% of original thickness during forming. Typical bends that can be made are: Pittsburgh lock, 90-deg crimp bend, 180-deg bend, double Ogee roll. Some spinning operations can also be performed.	Can be processed like plain metal sheet provided dies are in good condition. In many cases lubricity of vinyl actually facilitates stamping.	Limitations imposed mostly by base metal. No definite limitations can be set; allowable draws can only be determined by shop experiments. Nevertheless be sure to: 1. Provide extra thickness of vinyl for deep draws so that it will not thin out too much. Allow for thickness by opening up die clearances or reducing metal gage. Vinyl can compress up to 40% during forming. 2. Allow for change in appearance with textured or directional patterns. In some cases change in pattern can actually add to appearance. 3. Use standard lightweight die lubricants. Water soluble and silicone lubricants are recommended and sheets of heavily waxed paper have been used successfully. 4. Remove grease or dirt with unleaded gasoline, mild detergent or powder spray. Do not clean with trichlorethylene vapor degreasers or chlorinated solvents.
	VINYL (PVF)-LAMINATES No protection required during forming. However, handling care is required because scratches can mar untextured, solid-color surface.	Same as above.	Most present applications are for relatively simple flat sheet and little forming experience has been accumulated. However, no problems are foreseen provided that dies are kept clean and tolerances are opened up slightly to allow for laminate thickness. Right angle bends have been put into building panels with no effect on appearance.		
	POLYESTER-METAL Usually fabricated with protective paper.	Same as above.	Can be deep drawn, lock seamed, roll formed, crimped, bent and pierced without harm provided dies are in good shape.		
TEXTURED AND EMBOSSED METALS	No protection required.	Can be handled like ordinary flat sheet.	Just as workable as plain metal. Can be bent and formed with standard sheet metal working machines such as folders, brakes, slip rolls, etc. Die clearances should be adjusted for cross-sectional thickness instead of metal thickness. Bend radii should be at least twice cross section thickness. Sharper bends can be obtained with deep patterns if bend lines fall on apexes of the design.	Same as with plain sheet. For piercing operations a "punch and stripper" assembly is suggested to minimize die breakage.	No pattern distortion up to 1-in. depth. Greater depths possible if moderate pattern distortion is not objectionable. Stress-relief annealing is suggested for deep and difficult draws.

HOT DIPPED, OTHER PLATED METALS	GALVANIZED (ZINC-COATED) None required (should be protected against discoloration during storage).	Can be handled like ordinary sheet.	Can be formed into channels, moldings, etc., with same equipment used for mild steel. Forming rolls should be highly polished. Light lubricant may be required (often it need not be removed after forming).	Can be stamped like ordinary sheet.	High grades withstand severe drawing without peeling or flaking. Average die clearances usually satisfactory; however, for best results some clearance should be allowed for coating thickness. Standard lubricants are recommended; they do not have to be removed except for appearance or if they are corrosive (e.g., sulfur compounds or alkaline soaps).
	ALUMINIZED Not usually required.	Can be handled like ordinary sheet.	Can be bent 180 deg over a diameter twice its thickness without peeling or flaking.	Will withstand moderate stamping and drawing operations without damage. Adequate die clearance and lubrication are necessary in drawing to prevent destruction of coating by scraping action of dies.	
	TIN-COATED None required.	Can be formed by most standard methods. Specify adequate coating thickness at severe bends to prevent exposure of metal.		Is moderately stamped to provide strengthening ribs or sections.	Not normally used.
	TERNE OR LEAD-COATED None required.	Can be handled like ordinary sheet.	Will withstand as much bending as base metal.	Excellent stamping and drawing properties. Combination of lubricating surface (surface has a soft and greasy feel) and ductility promotes die forming and stamping operations.	
SPECIALLY FINISHED ALUMINUM	COLOR ANODIZED Normally no protection required during forming. However, care is required to prevent handling damage.	Can be handled like ordinary aluminum.	Cannot be formed as vigorously as plain aluminum. However, can withstand moderate forming operations including shallow drawing. Design should be checked with sheet manufacturer and by shop experiments.		
	SPANGLED None.	Because of integral, metallurgical surface, can be handled like standard aluminum alloys.			

4 HOW TO JOIN AND FASTEN THE MATERIALS

MATERIAL ↓	Brazing	Soldering	Welding	Mechanical Fastening	Adhesive Bonding
PREPLATED METALS	Not normally used; however can be beneficial in joining copper-plated parts.	Not too popular but has been used with most materials, especially copper, brass, buffed nickel and even zinc. Success depends on use of right flux. Chromium-plated materials cannot be soldered unless plate is removed at joint area.	Spot welding is popular, especially for light gages. Seam and projection welding can also be used. Spot welds not readily visible on satin or bright finishes provided electrodes are clean and good provision is made for heat dissipation. Heat shrinkage marks may occasionally show, but the coating is never burned off. In hidden areas all methods can be used and no special precautions are needed.	Most popular fastening method. Fasteners may be incorporated in hidden areas. If not, watch out that surfaces are not damaged during fastening operations.	No problems, but rarely used.
PREPAINTED METALS	Cannot be used: high temperatures destroy coatings.	In rare cases low temperature soldering has been used.	Although it can be used, welding is not popular for joining prepainted parts. Usually paint has to be scraped off weld area which, however, can be repainted. Special weldable coatings can be obtained but are usually limited to light pieces not requiring much heat.	Any method can be used. In most cases designs can be made to incorporate fasteners in hidden areas so as not to detract from appearance. Modification of designs for rivets has worked out for many parts, especially large components.	Not normally used because adhesive does not bond as well to coated metal as to uncoated metal. Usually, coatings are not formulated for adhesive bonding; however, method should not be ruled out completely.

4 HOW TO JOIN AND FASTEN THE MATERIALS (continued)

PLASTIC-METAL LAMINATES	VINYL (PVC)-METAL Not usually performed because of high temperatures involved. These methods do not provide a very strong joint and have only been used in limited production.		Limited weldability of vinyl-metal laminates has held back some product applications. Nonetheless, satisfactory welds can be made by projection resistance welding which is made through back of laminate and does not damage the vinyl or cause any loss of adhesion. Can be used to apply studs to back side for subsequent assembly. Welding technique is more costly than conventional spot welding because welding cycle is longer and specialized equipment is required.	No limitations. Keep in mind that fasteners may mar outside appearance. This can be overcome by designing flanges, studs, etc., for hidden inside fastening.	Can be used, especially when outside appearance must be preserved. Be sure that adhesive is compatible with vinyl and coloring pigments, inks or dyes.
	VINYL (PVF)-METAL Same as above.		No information available.	Same as above.	Same as above, however, little application is foreseen.
	POLYESTER-METAL Same as above.		Generally same recommendations as for PVC-metal laminates.	Parts usually joined by mechanical fasteners and/or crimping.	Not recommended; however, suitable adhesives are being explored.
TEXTURED AND EMBOSSED METALS	Same as for standard sheet metal.		Most standard methods can be used in hidden areas. Care required where joints are visible. For best results edges should be flattened to facilitate welding. Popular are: **Butt welding:** Excellent results obtainable with patterns up to 0.015 in. deep. **Spot welding:** For best results place copper wire braid between electrodes and metal to form a nest for pattern and electrode. Alternatively, metal can be flattened if pattern distortion at weld is not objectionable.	Most popular fastening method. Keep in mind that effective fastener bearing area may be reduced because of ridges.	Standard methods can be used. Also, parts can be provided with adhesive backing for placement on flat surfaces, particularly in decorative applications (e.g., appliances).
HOT DIPPED, OTHER PLATED METALS	GALVANIZED (ZINC-COATED) Can be used; care needed to protect zinc coating from flame and thus heavy coat of brazing flux in thick paste form may be required.	Can be used provided joints are fluxed properly. Paste fluxes not recommended but some cored solders perform satisfactorily. All fluxes must be completely removed before painting.	Many common methods can be used—metallic arc, oxyacetylene or resistance. Continuous resistance seam welding not recommended. Check with materials supplier for specific recommendations.	Most popular fastening method.	Few limitations, but rarely used because of relatively high cost.
	ALUMINIZED Silicon bronze rods provide full sheet strength. Aluminum alloy brazing not recommended for lock seam joints where water or air tightness is needed. Use flux and torch method recommended by manufacturer.	Insoluble aluminum oxide film prevents wetting; however, special methods can be used (e.g., electroplating aluminized steel with copper or nickel and then soldering).	Many methods, such as oxyacetylene, electric arc, seam, spot, atomic hydrogen and inert gas methods, can be used. Check with materials supplier.	Most popular fastening method.	Same as above.
	TIN-COATED Not normally used.	Excellent soldering properties. Solders with low tin content generally used because of strength and low cost.	Not normally used.	Mechanical joining in conjunction with soldering is most popular method.	Not normally used.
	TERNE OR LEAD-COATED Not used; brazing can melt surface.	Excellent soldering properties.	Can be welded. Welding may destroy coating at contact area; this area may be left as is, painted, or refluxed and touched up with molten lead.	Most popular fastening method.	Permissible, but rarely used.
SPECIALLY FINISHED ALUMINUM	COLOR ANODIZED Can be joined by standard brazing, soldering and welding techniques.			No limitations.	No limitations, provided adhesive is compatible.
	SPANGLED Same procedures and limitations as standard aluminum alloys.				

decorative finish is wanted (e.g., condenser cans and hidden parts in door locks). The zinc coating also provides a good paint base, provided the surface is first given a chemical conversion treatment.

Copper-plated steel is another good example of a functional finish. As shown in the case history (bottom), it provides a good lubricating surface for deep drawing operations and also makes a good base for further electroplating. The material has also been selected for its electrical conductivity, its usefulness in low temperature tinning and high temperature brazing operations, and as a stop-off coating in carburizing operations.

Prepainted metals are also popular for functional applications; this is borne out by the wide number of functional resins that are now available. In addition to providing decorative appearance these coatings prevent the base metal from corroding and can provide good resistance to chemicals and foods (epoxies), toughness and resistance to forming damage (vinyls), and good resistance to outdoor exposure (acrylics). A complete description of these coatings is given in the first of the accompanying tables.

Textured Metal: It Looks Good, Hides Handling Marks

Ardmore Products, Inc.

Typewriter trim panel is made of ribbed metal which retains good initial appearance after long periods of hard usage. Ribbed material is bought in coil, 0.025 in. thick by 11.625 in. wide; application uses 20,000 lb of carbon steel per month.

Gasoline pump scuff panel is made of 0.037-in. textured 430 stainless steel with No. 2 finish. Previously used baked enamel panels were easily scratched, dented and corroded.

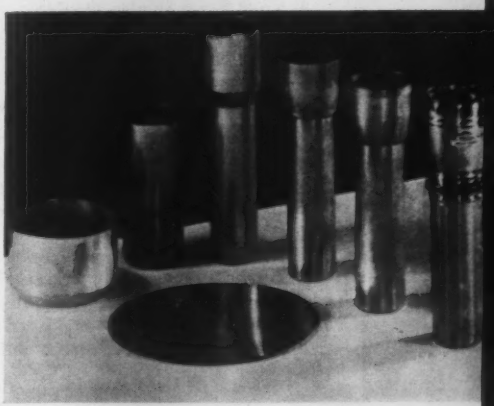
Preplated Metal: A Classic Example of How It Cuts Costs

This flashlight case has come to be one of the most famous examples of how prefinished metals can cut costs—it saved the Blake Mfg. Div. of Ray-O-Vac Co. more than $100,000 a year.

Previously, the case was fabricated from brass and subsequently chromium plated. Because of the expense involved, engineers explored the possibility of using a special drawing-quality steel with a preplated electrolytic copper coating on both sides. The copper coating acts as a good die lubricant and is a good base for further plating. Copper plated steel also costs less than brass.

Plated coils are fed into a double-action press which cuts a 6.398-in. dia round blank (shown at bottom of photo). The blank is then formed into a 7½-in. long cylinder by four successive drawing operations without annealing. Compared to previous brass cases, the preplated strip can be fabricated more rapidly and eliminates two annealing and pickling operations and one redraw.

Total savings, including savings in materials, fabrication and finishing, range from 3 to 6 cents per flashlight; at a production rate of up to 1400 cases per hour such savings added up to an average of $8300 per month. Not only is the case less expensive to make but it is stronger and of a higher quality than the original brass case.



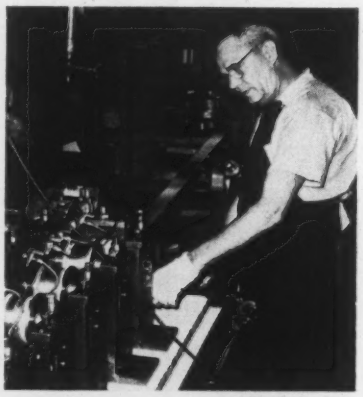
Thomas Strip Div., Pittsburgh Steel Co.

Prepainted Metal: Here It Replaces Preplated Metal

Not all prefinished metals are used as a replacement for metals that are finished after fabrication. These photos show a unique application in which a manufacturer of table legs cut costs in half by switching from preplated metal to prepainted metal.

The manufacturer, Quaker Stretcher Co., previously obtained a bright finish by using prefinished brass-plated steel. However, a comparison of materials showed that by using a prepainted, simulated brass coating over a tinplate base he could obtain a more durable material with the same appearance at lower cost.

In the photo at the right, 2.25 by 0.016-in. coil is being unwound into a series of 12 rolls that form it into ⅝-in. tubing. An estimated 50 miles of tubing are formed daily. High resistance of the finish to forming damage is suggested in the photo below in which machine is simultaneously bending and piercing three lengths of tubing.



Litho-Strip Corp.

Don't Forget Decorative Mechanical Finishes

In discussing prefinished materials it is easy to overlook the fact that many standard sheet metals, notably stainless steel, aluminum and copper can be purchased with a mechanical finish that eliminates the need for any finishing after fabrication. Mechanically finished sheet can be obtained directly from the mill in a series of finishes from dull matte up to highly polished. Although the sheet is not usually used for small, intricately shaped sheet parts it is particularly well suited for large, flat areas. In such cases it may be cheaper to buy the sheet with a mechanical finish that has been put on at the mill, rather than shop-finish the part after fabrication.

Stainless steel: many mill-polished finishes

Stainless steel can be obtained in several polished finishes, notably Nos. 4, 6, 7 and 8. All of the sheets are available with one or both sides polished. When polished on one side only, the other side is usually supplied rough ground to obtain necessary flatness.

No. 4 finish is a general purpose polished finish that is widely used for store fronts, and restaurant, kitchen and dairy equipment.

No. 6 finish is a dull satin finish with lower reflectivity than No. 4. It is used principally for architectural applications and ornamental products where a high luster is undesirable. It can also be used effectively to contrast with bright finishes.

No. 7 finish has high reflectivity, obtained by buffing a finely ground surface without removing the "grit" lines. It is used mainly for architectural and ornamental purposes.

No. 8 finish is the most reflective stainless steel finish and is essentially free from grit lines. Its principal use is for press plates and small mirror reflectors.

A No. 3 finish is also available which, though it has an intermediate polish, is primarily intended for use where subsequent finishing will be performed after fabrication.

Aluminum: matte to mirror-bright finishes

The so-called standard bright finish obtainable with aluminum sheet is actually a mirror-bright finish, one of the brightest mechanical finishes obtainable. It is particularly valuable for decorative parts.

Standard mill finishes are also available which are characterized by a matte appearance that varies with thickness and the alloy used. And a satin-like finish can be obtained by pattern rolling. This finish has a brush-applied appearance but is actually impressed into the sheet by rolls. It is available in three satin-like patterns, one of which is being used for the 1961 Ford Thunderbird interior (it is subsequently given a clear, colored finish).

Acknowledgments

The author would like to express his appreciation for the assistance of personnel and literature from the following companies in preparing this article:

Aluminum Co. of America
American Nickeloid Co.
Apollo Metals, Inc.
Ardmore Products, Inc.
Armco Steel Co.
Arvin Industries, Inc.
Croname, Inc.
E. I. du Pont de Nemours & Co., Inc.
Enamelstrip Corp.
Fromson Orban Sales Corp.
Fryling Mfg. Co.
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Olin Mathieson Chemical Corp.
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Republic Steel Corp.
Revere Copper and Brass, Inc.
Reynolds Metals Co.
Rigidized Metals Corp.
Roll Coater, Inc.
Sharon Steel Corp.
Shwayder Bros., Inc.
Simoniz Industrial Products, Div. of Simoniz Co.
Technical Processes Div., Colonial Alloys Co.
Thomas Strip Div., Pittsburgh Steel Co.
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Naugatuck Chemical Div., U. S. Rubber Co.
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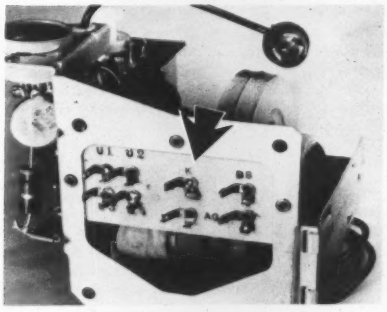
SILICONE NEWS

for design and development engineers • No. 85

FOR BETTER TV

Production of flyback transformers for RCA "Living Color" TV sets is expedited by the use of terminal boards made from silicone-glass laminates produced by Taylor Fibre Company of Norristown, Pa.

Bonded with a Dow Corning silicone resin, these laminates easily withstand 250 C continuously . . . much higher temperatures for shorter times. Soldering heat doesn't loosen terminals or slow production. Good electric and physical properties, ease of fabrication, and resistance to creep-under pressure of terminal fasteners add up to a top quality high voltage laminate that lends itself to mass production. *No. 242*



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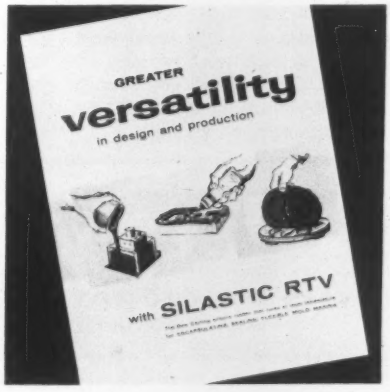
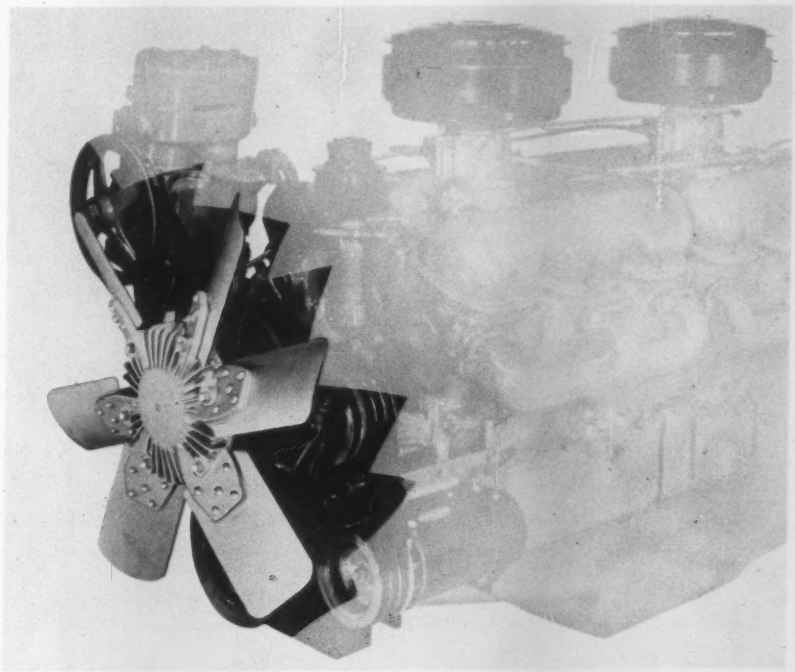
Silastic RTV is a down-to-earth working tool for design and *(Cont. Pg. 2)*





More Horses, Less Fuel

Fuel consumption is an important element when computing operating costs for trucks, buses, off-the-road vehicles and earth-moving machines. That's why the silicone-filled Thermo-Modulated Fan Drive made by Schwitzer Corporation, Indianapolis, delivers impressive savings. Here's how:

Conventional fan-drives waste fuel because they overwork—cool more than necessary under a majority of operating conditions. Engines can lose up to 10% of total power output just driving the fan when cooling is not required. The Schwitzer fan drive eliminates this waste by relating fan speed to engine coolant temperature.

Because engine power absorbed by a fan is a cubic function of its speed, even slight reductions in fan RPM result in significant fuel savings. Schwitzer claims a 5 to 10% fuel savings and, in addition, attributes reduced maintenance, longer engine life, and a substantial reduction in noise to the use of their drive on commercial vehicles.

Operation of the fan drive is based on simple principles: Torque is transmitted from the input shaft to the fan by the shearing of a fluid film between input and output plates in a silicone fluid filled housing. The control element, which reacts to engine temperatures, varies the thickness of the fluid film between the plates to change fan speed. Naturally, the properties and stability of the fluid medium determine in large measure the accuracy, responsiveness and reliability of the device.

Schwitzer engineers chose a Dow Corning silicone fluid for the viscous drive medium because 1) it is uniquely resistant to breakdown under shear; 2) it retains near-constant viscosity (uniform driving force) over wide temperature spans; 3) it resists oxidation, won't evaporate, thicken or thin out after extensive use.

For more information on how the outstanding properties of silicone fluids can aid you in damping, torque conversion and hydraulic applications, circle . . . *No. 241*

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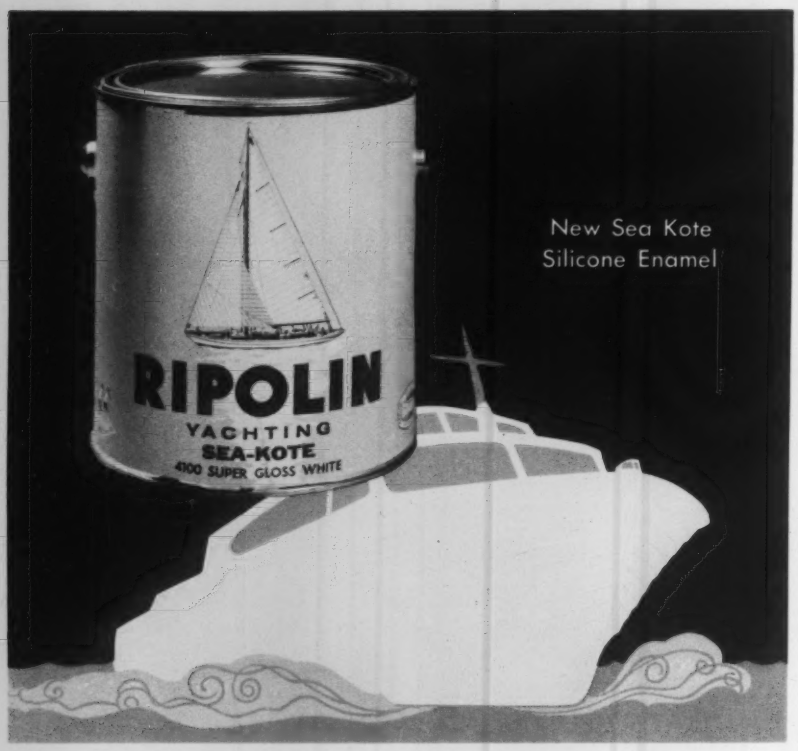

New Enamel Keeps Gloss Longer

You can make your product's brand-spanking-new factory paint job last almost indefinitely by specifying a finish based on Dow Corning silicone resins. A good example of the "extras" you can expect with silicones is found in the new SEA-KOTE marine enamel produced by the Glidden Company, Cleveland, Ohio.

Glidden is confident its new silicone base SEA-KOTE Super Gloss enamel will retain 90% of its original rich gloss after a full year's service above or below waterline in fresh water, or above waterline in salt water. For boat owners, this means no more mid-season refinishing, new convenience and increased satisfaction.

Glidden has tested the enamel in actual use for four years under the worst possible conditions. In addition to repeated exposure to sun, wind, rain and moisture, SEA-KOTE has withstood the ravages of sulfurous gases, sewage infested harbors, oil slicks, exhaust fumes, salt air and exposure to prolonged sunlight. Silicones help keep the paint's slick surface dirt-free . . . toughen the film so it will retain its high gloss, mirror smooth finish almost indefinitely.

If your product could use a coat of beauty that lasts like a coat of armor, it will pay you to investigate the ever-increasing number of silicone-based baking enamels and air dry finishes offered by leading paint formulators. For more information and list of sources, circle . . . . *No. 244*

new literature on silicones

Electronic Engineer's Guide describes all the silicone products that contribute to realiability, miniaturization and environmental protection of electronic components. From satellites to seismographic instruments, this 16-page electronics engineer's guide describes the various forms of silicones that help improve design. *No. 245*

Space Age Silicones are described in thirty typical application stories. Utilization of silicone compounds, fluids, lubricants, protective coatings, rubbers, resins, potting materials and sealants are illustrated for your consideration. This valuable brochure offers solutions to many problems encountered in designing space age aircraft and ground support equipment. *No. 246*

Four Simple Steps to making silicone rubber molds for short run castings are described in an article reprinted from PRODUCT ENGINEERING. Silastic RTV, the fluid silicone rubber that cures at room temperature, makes it possible to produce flexible molds and patterns for casting metal or plastic parts, even with most intricate detail, cheaply and quickly. An ideal means of making prototype parts. *No. 247*

Does silicone rubber resist solvents, chemicals, oils, fuels, and other fluid media? Sometimes it does and sometimes it doesn't. New 20 page bulletin lists the effects of over 250 fluids from coffee to jet fuel on Silastic silicone rubber after immersion for varying times and temperatures. For free copy, circle . . . . . *No. 248*

SILASTIC RTV *(Continued)*

production engineers. When poured or squeezed into place, this silicone rubber cures at room temperature to a tough, resilient solid that has the resilience of rubber *plus* the indestructibility of its silicone ancestors. Silastic RTV's physical and electrical properties are unaffected by heat, cold, moisture, ozone and corona.

A just-released eight-page brochure illustrates and gives details about Silastic RTV and its applications. Included also is a Selector Guide which describes the properties of each of the various RTV systems. To obtain your copy, circle . . *No. 243*

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Price of nickel has been increased 10%. New price set by International Nickel Co. of Canada, Ltd. is 81¼¢ per lb. This is the first price increase for nickel in 4½ years.

Price of nickel-bearing stainless steel remains unchanged at present following Inco's price increase on nickel. A major producer did announce price increases ranging from ½ to 2¼¢ per lb, but withdrew when other major producers failed to follow suit.

Commercial availability of pyrolytic graphite has been announced by the Metallurgical Products Dept. of General Electric Co. The material, described in the Aug '60 issue of this magazine (p 165), is supplied as plates, cylinders and special shapes.

More high purity silicon is available as the result of the start-up of Dow Corning Corp.'s new plant in Hemlock, Mich. Polycrystalline silicon, as well as zone-refined single crystals, is being produced. Initial plant capacity is 25,000 lb per year.

Prices of FEP fluorocarbon resin and film have been cut by Du Pont. The resin price has been reduced 30% to $6.60 per lb in truckload quantities. Not long ago price of the fluorocarbon resin was dropped from $11.60 to $9.60 per lb (M/DE, Feb '61, p 129). New film prices are $10 per lb for 2-mil or thicker film, $11.50 for 1-mil film, and $15 for ½-mil film.

Look for polyethylene consumption to reach 1.6 billion pounds by 1965, says Vincent D. McCarthy of U. S. Industrial Chemicals Co., Div. of National Distillers and Chemical Corp. McCarthy says that rated production capacity for conventional polyethylene today is close to 1.7 billion pounds—already large enough to handle the 1965 projected demand.

A 1½¢-per-lb cut in the price of man-made natural rubber (polybutadiene) has been made by Firestone Synthetic Rubber & Latex Co. New Price is 30¢ per lb in truckload lots.

Availability of new graphite-metal compositions for use as bearings, seals and electrical contacts has been announced by Dixon Sintaloy, Inc. The bonded graphite materials are made by a powder metallurgy technique developed by Ford Motor Co. (M/DE, Jan '61, p 144).

Price of polypropylene film has been reduced by AviSun Corp. New price is 64¢ per lb for all gages in shipments of 500 lb or more. Previously, the plastics film sold for 70¢ per lb in shipments of 10,000 lb or more.

A complete roundup of current prices will appear in the September issue.

Familiar product . . . new use

In the hands of experts, a well-known product has found a new use, brought about by today's fast moving technology. A spacer with electrical insulating and special mechanical properties was required for this stud-mounted power transistor. CDF solved the problem with paper phenolic rolled tubing, a long-established grade. Fabrication of the spacer is accurate and low cost on automatic screw machines.

Result: Reliability is assured through use of a time-tested and proven material, while costs are kept to the minimum.

A few facts on the tubing: (1″ x 1⅛″)

Dielectric strength, perp., vpm	400
Min. density	1.12
Water absorption, %	3.0
Axial compression, psi	13,000

CDF® **CONTINENTAL-DIAMOND FIBRE**

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(cont'd from p 128)

not be accurately analyzed, and we still do not know which phases contain them.

▸ The effect of unique alloying additions such as hafnium, rhenium or yttrium.

▸ Powder metallurgy techniques such as dispersion strengthening. Specific powder metal alloys still have to be developed to take advantage of the process's unique shape/composition adaptability.

▸ Effects of temperature on the morphology of dispersed phases in both alloy systems. These may be as valuable to the designer as development of new alloys.

4. Graphite and refractory compounds

Graphite is unique since it resembles both metals and ceramics in some of its properties. Below about 100 atm pressure it has no liquid phase and it sublimes, the sublimation temperature at 1 atm being about 7000 F. Its extreme binding energy makes it the highest-temperature-stable elemental solid. Like ceramics, it is porous, refractory, and has limited ductility at ordinary temperatures.

The most outstanding advance in carbon and graphite technology —which has extended the useful temperature range of structural materials to 5400 F—has been the development of recrystallized bulk graphite. As Fig 4 shows, recrystallized graphite has less creep at 5400 F than conventional graphites show at 4700 F.

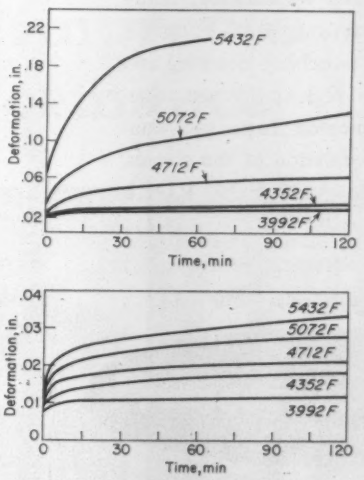
Pyrolytic graphite is another structural and coating material that is becoming available in limited quantities. Its extreme anisotropy is reflected in its physical properties which may differ by orders of magnitude in different crystal directions.

Refractory hard metals—compounds formed by reacting boron, carbon, nitrogen or silicon with each other or with transition metals such as titanium, vanadium, chromium, zirconium, columbium, molybdenum, hafnium, tantalum and tungsten—are the materials that exhibit the highest melting points (up to 7200 F) known today. Unfortunately, very few high temperature data are available, and the low temperature data are often contradictory and vary over wide ranges because characteristic materials are difficult to prepare in pure form.

Useful properties are: excellent high temperature strength, good chemical stability and good oxidation resistance. Major drawbacks are brittle behavior and lack of reliable property data.

The future

▸ Complete exploitation of graphite as a structural material at



4—High temperature creep of ATJ graphite (top) and ZTA graphite (bottom). Fiber stress in both cases is 3800 psi.

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Rodney produces stainless steel strip . . . all alloys . . . in widths from ⅛" to 24" . . . at gauges from .012" to .0003". Rodney also rolls high temperature alloys and other special alloys on a production basis. Aluminum alloys, carbon steel strip and specialty custom rolling are also handled.

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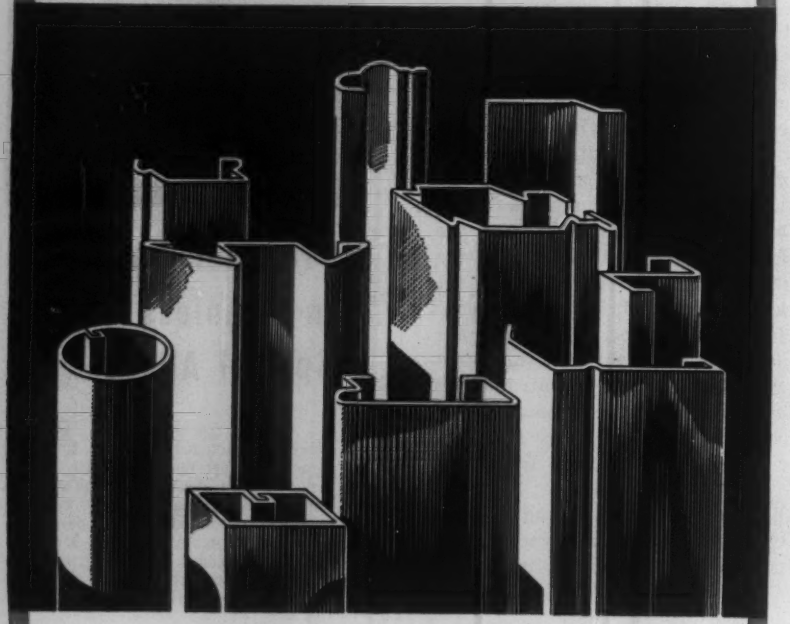

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high temperatures must await development of an oxidation resistant coating compatible with the expansion characteristics of graphite. Such a coating will make graphite competitive with other refractory materials at low temperatures.

▸ Brittleness of refractory hard materials, if real, will effectively reduce the widespread use of these materials in the future. The problem, however, has not been fully investigated and value judgments cannot be made until a comprehensive attack on the problem is completed. To date, there has been no report of any fundamental investigation in this area.

5. High temperature coatings

All that has gone before in this summary can be directly related to the problem of obtaining adequate coatings to provide oxidation resistance for refractory materials. All of the materials have poor oxidation resistance and many have volatile oxidation products. Considerable effort has been expended to develop refractory alloys that are oxidation resistant, but none have been developed which are suitable for long-time service at elevated temperatures.

The current status of high temperature coatings for the refractory metals can be summarized as follows:

1. Coatings for molybdenum are presently undergoing the transition from advanced research and development to experimental structures. Complex intermetallic or silicide types of coatings appear to be able to provide protection up to 3000 F for a few hours.

2. Coatings for columbium are currently undergoing considerable research and development. The more advanced coatings are applied by spraying and are there-

Tough, durable Mylar® cuts costs . . . improves product performance

For example, "Mylar"* polyester film gives many products extra resistance to chemicals, moisture and aging . . . lengthens their life. Today, "Mylar", with its high tensile strength in thin gauges, is improving the performance of products as different as wire and cable tapes and loose-leaf-sheet protectors.

Can this unique plastic film and products made with it help you? For more information on "Mylar", write the Du Pont Company, Film Dept., Room S-8, Wilmington 98, Delaware.

1. Conveyor belts of "Mylar" are easy to install, need fewer replacements, are easy to keep clean . . . cut "downtime," reduce costs.

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3. Roll-back shelving of "Mylar" gets rid of retail stacking and stocking headaches. As shoppers remove items, "Mylar" rolls back.

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Molasses Dairy Feeds Clog Scale Openings

Stainless steel interiors of automatic feed weighing scales have long provided good service for users of Richardson Scales for weighing molasses content feeds. But as molasses content increased, so did the time and effort required for cleaning.

Usually twice-a-day cleaning sufficed. But the higher the molasses content, the faster the feed adhered and built up on all platework. Downtime for cleaning went even higher.

Now Richardson Scale Company uses R/M "Teflon" sheets wherever molasses feed makes contact with the scales. Field experience proves that now scales never clog, cleaning requires only a moist sponge instead of a metal scraper and only 1/10 as much time as before.

R/M Bondable "Teflon"* Cuts Cleaning Time 90%

Do you have an application which can utilize the non-adhesive property and low coefficient of friction of "Teflon"? Talk to R/M—headquarters for "Teflon" rods, sheets, tapes, hose, machined parts, with or without bondable surfaces. Write for information or call your nearest R/M district office.

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fore limited to columbium shapes with exposed surfaces.

3. Coatings for tantalum and tungsten are in the preliminary research and development phases. Aluminide and silicide coatings show promise for tantalum and the silicides are of some interest for tungsten.

The future

▸ The primary requirement for developing future high temperature coatings is really a broad program of basic research. At this moment, fundamental knowledge is not sufficient to adequately support future development of protective coatings for the refractory metals.

Based on AIME Conference

This article is based on five papers presented at the Technical Conference on High Temperature Materials sponsored by AIME in Cleveland this past April:

"Status and Future of Graphite and Refractory Compounds," by R. T. Dolloff and J. T. Meers, National Carbon Co.

"Status and Future of Molybdenum and Columbium Alloys," by L. P. Jahnke, General Electric Co.

"Status and Future of Tantalum, Tungsten and Their Alloys," by H. R. Ogden and D. J. Maykuth, Battelle Memorial Institute.

"Status and Future of Cobalt and Nickel-Base Alloys," by W. H. Sharp, Pratt & Whitney Aircraft.

"Status and Future of High Temperature Coatings for Refractory Metals," by J. J. Gangler, Lewis Research Center, NASA.

This review of the papers is necessarily brief. The complete conference papers will be published in book form by Interscience Publishers.

(more ME&D on p 150)

START: Heated billet is centered between dies of the Slick Mill.

15 SECONDS
Upset-forging starts.

30 SECONDS
Rolling cycle starts.

40 SECONDS
Forging is completed.

55 SECONDS
Forging is removed from mill.

One minute... one circular forging

That's all the time it takes to convert a heated billet (100 to 2,000 lb) into a contoured forging on Bethlehem's unique Slick Mill.

But fast operation is only one reason why Bethlehem's Slick Mill turns out a top-quality forging at a price that's hard to match.

Ask us, or our nearest sales office, about the quick die changes, which make it possible—and economical—to set up production runs as small as 25 or 50 pieces. Ask about the low die charges which are made possible by the brief contact between die and work. Ask about the light-weight sections this mill can produce, without sacrificing strength.

We'd also like to tell you about the excellent grain flow, machinability, and soundness of every Bethlehem circular forging.

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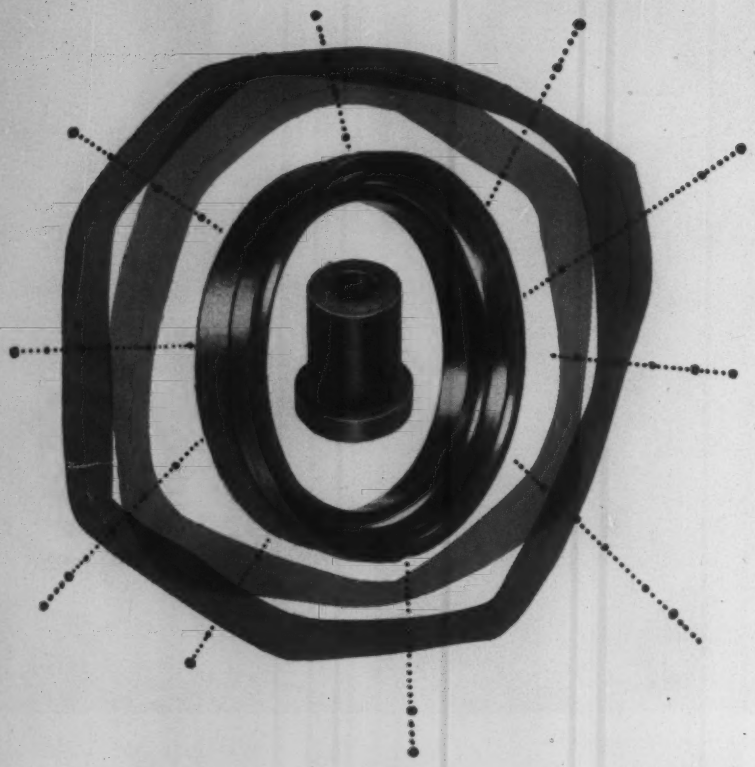

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MATERIALS ENGINEERING & DESIGN

TFE Rods in Rubber Isolate Missile Gyro

A gyroscopically stabilized flight reference system for aircraft has been successfully isolated from shocks and vibrations with a high internal damping mount.

The vibration mount, described in M/DE, Apr '60, p 168, consists of a multi-layer grid of Teflon rods embedded in a matrix of silicone rubber.

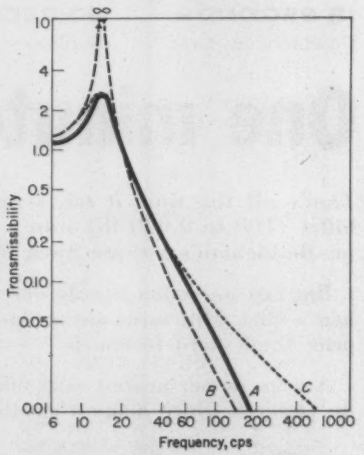
Stands adverse environments

According to R. H. Jacobson, Armour Research Foundation*, the vibration mount not only blocks extraneous vibrations from the gyro without interfering with its operation, but also has high resistance to adverse environments such as high humidity, fungus, salt spray, hydrocarbons, and temperatures from —100 to 500 F.

The mounting base for the gyroscope unit uses three sets of leaf springs (flexures) to allow motion in all directions. However, the springs provide very little damping; therefore, two TFE-silicone rubber damper elements were added in parallel with each spring.

Each damper element consists of a ¾-in. cube of Silastic 6508 silicone

* Now with Hallicrafters Co.



***Vibration transmissibility** of a TFE-silicone rubber mount (A); an undamped spring mount (B) and a viscously damped mount (C).*

C I B A

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rubber in which ⅛ to 1/16-in. long pieces of 0.085-in. dia Teflon tubing are randomly distributed. The damping action is produced by the high friction at the silicone-Teflon interfaces.

The gyroscopic unit weighs approx 20 lb; therefore the maximum load on each damper is about 10 lb. The spring rate for the flexures and damper that provides the desired natural frequency in the 15 to 20 cps range was established as 300 lb per in.

Superior to viscous damper

The vibration transmissibility of the system was tested from 6 to 2000 cps, the anticipated disturbance frequency range. Results of the experiment are shown in the accompanying graph. It compares the transmissibility of one unit with a single degree of freedom with that of an undamped linear system and with the theoretical transmissibility of a linear system having 0.20% viscous damping.

The new damper combines the best features of both systems. Its resonance amplification is as low as the viscous system's and its high frequency isolation is almost as good as the undamped system's.

Copper-Zirconium Alloy Used in New Inverter

Rotor bars and end plates made of a copper-zirconium alloy are being successfully brazed for a new inverter power source for flight instrumentation systems.

The oxygen-free, high conductivity alloy was described in M/DE, May '60, p 16.

The brazing operation posed a particularly difficult design problem because the joint must withstand the centrifugal force generated by rotor speeds of 12,000 rpm while operating at temperatures above 300 F. The copper-zirconium alloy maintains a tensile strength of 70,000 psi, Rockwell hardness of 60, and IACS conductivity of 90-93%, even after brazing at 1200 F.

When a copper-silver alloy failed to meet performance requirements, engineers of Bendix Corp.'s Red Bank Div. considered backing the end plate faces with stainless steel,

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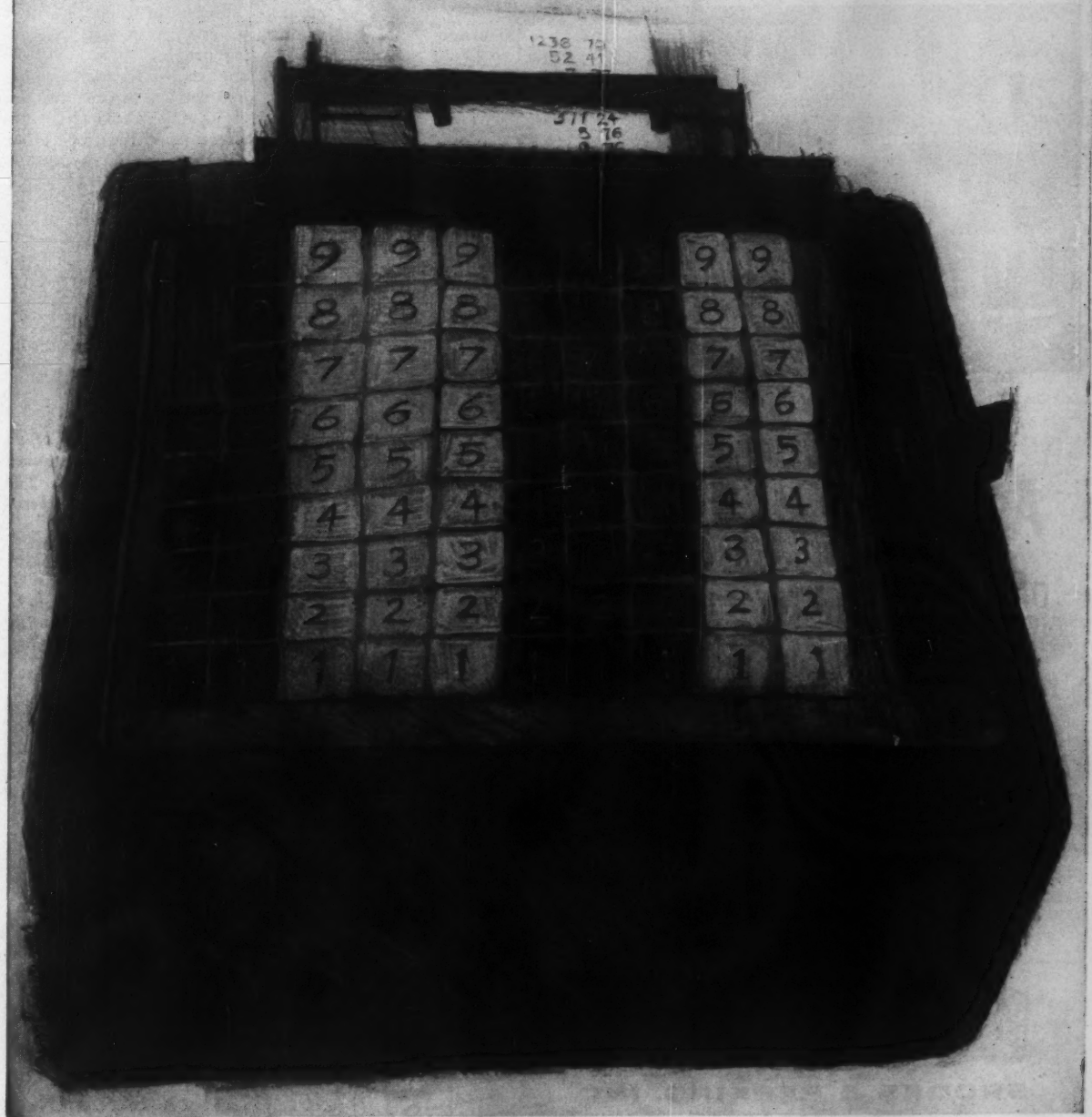

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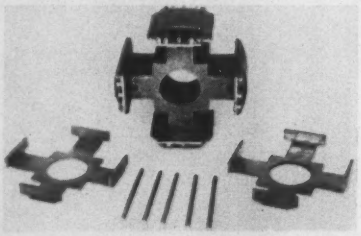
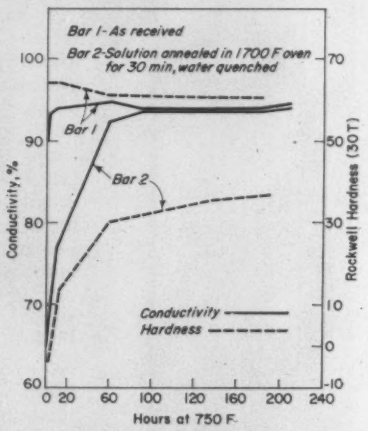
but that proved prohibitively expensive.

Bendix engineers put specimens of the copper-zirconium alloy, developed by American Metal Climax, Inc. and supplied by Nippert Electric Products Co., through a extensive series of tests. Results of their life text evaluation are given in the accompanying graph.

Since the copper-zirconium alloy was adopted for use in the inverter, several thousand of the airborne power sources have been operating without a failure caused by centrifugal stresses.



***Rotor bars and end plates** of an airborne inverter, bottom, are brazed into the complete rotor, top. The unit spins at 12,000 rpm at temperatures of 300 F and above.*



***Hardness and conductivity** of two copper-zirconium alloy bars during exposure to 750 F.*

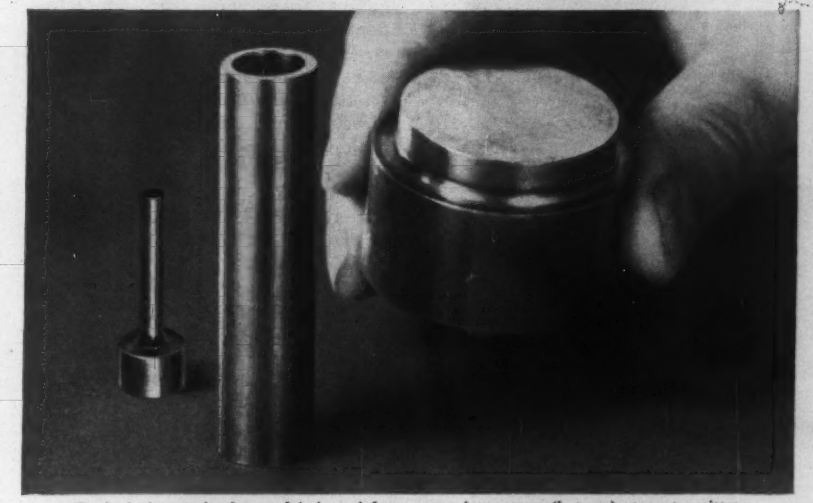
Nondestructive Test for Plastics Strength

The basic goals have been achieved in developing nondestructive test and evaluation methods for deter-

Linde materials & coatings News

LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

Crystal tungsten opens up a new era for the metal in electronics



Typical electronic shapes fabricated from crystal tungsten (l. to r.): target emitter; zero-porosity tungsten anode for high-powered electron tubes with fluid cooling; high-power vacuum switch contact of zero-porosity tungsten mounted to copper.

A new method of consolidating tungsten powder into tungsten ingot has been created by LINDE's Crystal Products Department. This new material—in crystal form—changes the whole approach to use of tungsten in electronic applications.

Compared to metallurgically prepared (PM) tungsten, crystal tungsten offers 5 to 15 per cent higher electrical conductivity. Thermal conductivity is about 20 per cent higher at 500°F, resulting in improved heat dissipation. These properties can be advantageous in electronic design.

Useful in vacuum devices

The high purity and zero porosity of the crystal tungsten also suggest its use not only in electrical contact points, but also in vacuum switches, electrical leadins in vacuum tubes, and applications where outgassing or leakage is a problem. Their purity and lack of grain boundaries provide more even electron emission, making them valuable in several high pressure vacuum or open air switches. Other uses include: flexible sheet in electronic tubes; x-ray and anticathode targets.

LINDE crystal tungsten is considerably more ductile than undoped PM tungsten. It can be drawn into wire as fine as 1 mil, giving greater yield of finished product from the starting ingot. Although undoped crystal tungsten has a lower recrystallization temperature, it does have a yield point at about 150°F.

Material easily worked

Significant is the fact that it can be easily worked and at temperatures 800°F lower than working temperature for powder metallurgy or vacuum-arc cast tungsten—making it useful for a wide range of non-electronic applications. Present shapes include swaged rods from 1/10 to ⅜-inch diameter, as grown ingots up to ¾-inch diameter in production, and even larger diameters in development.

For more details on this new material, check the coupon below.

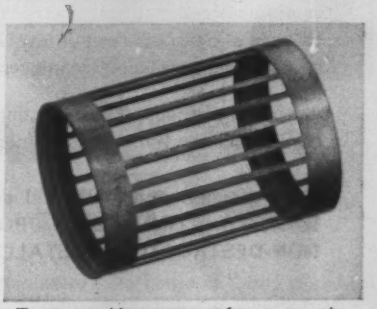
Super-hot process metal-coats and fabricates intricate parts

Dense, high-purity metal coatings for certain base materials, and the fabrication of odd shapes, are accomplished with "Plasmaplate," a super-hot plasma stream process developed by LINDE's Flame-Plating Department.

In operation, a high-current torch uses temperatures up to 30,000° F. to produce a supersonic stream of ionized gas—melt and accelerate to high velocity particles of any inorganic material that melts without decomposition.

High-purity coating materials—such as tungsten or other refractory metals—are thus permanently fused to the surfaces of materials such as graphite, brass, copper, steel, molybdenum, titanium, aluminum and others.

Parts of intricate configuration can be fabricated by depositing the coating material on a mandrel machined to the desired internal shape of the finished part. After the desired thickness is obtained, the mandrel is dissolved out by chemical means.



Tungsten grid cage—one of many complex shapes made by LINDE's "Plasmaplate" Process.

Thin coatings of tungsten carbide and other hard materials can also be applied to base metals by the LINDE oxyacetylene Flame-Plating "gun" process, to increase surface wear as many as 40 times.

For details on either of these LINDE processes, check the coupon below.

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mining the performance properties of plastics, according to a recent report.

According to S. Goldfein of the U. S. Army Engineer Research and Development Laboratories, investigators there have correlated the penetration resistance of 17 glass-reinforced plastics with the specimens' tensile, shear and compressive strengths and tensile modulii.

The penetration index curve of each plastic is first established by measuring the material's resistance to penetration by a 0.13-in. dia probe under a range of loads. This penetration vs pressure curve, is then mathematically related to the strength and elasticity properties of the plastic as determined by other means.

When fully developed, the method promises to provide a means of evaluating and characterizing plastics for design or inspection purposes.

Pearlitic Malleable Strengthens Gear Teeth

Gears for a small tractor transmission have been produced more economically by machining them from pearlitic malleable iron castings rather than from either gray iron or nodular iron.

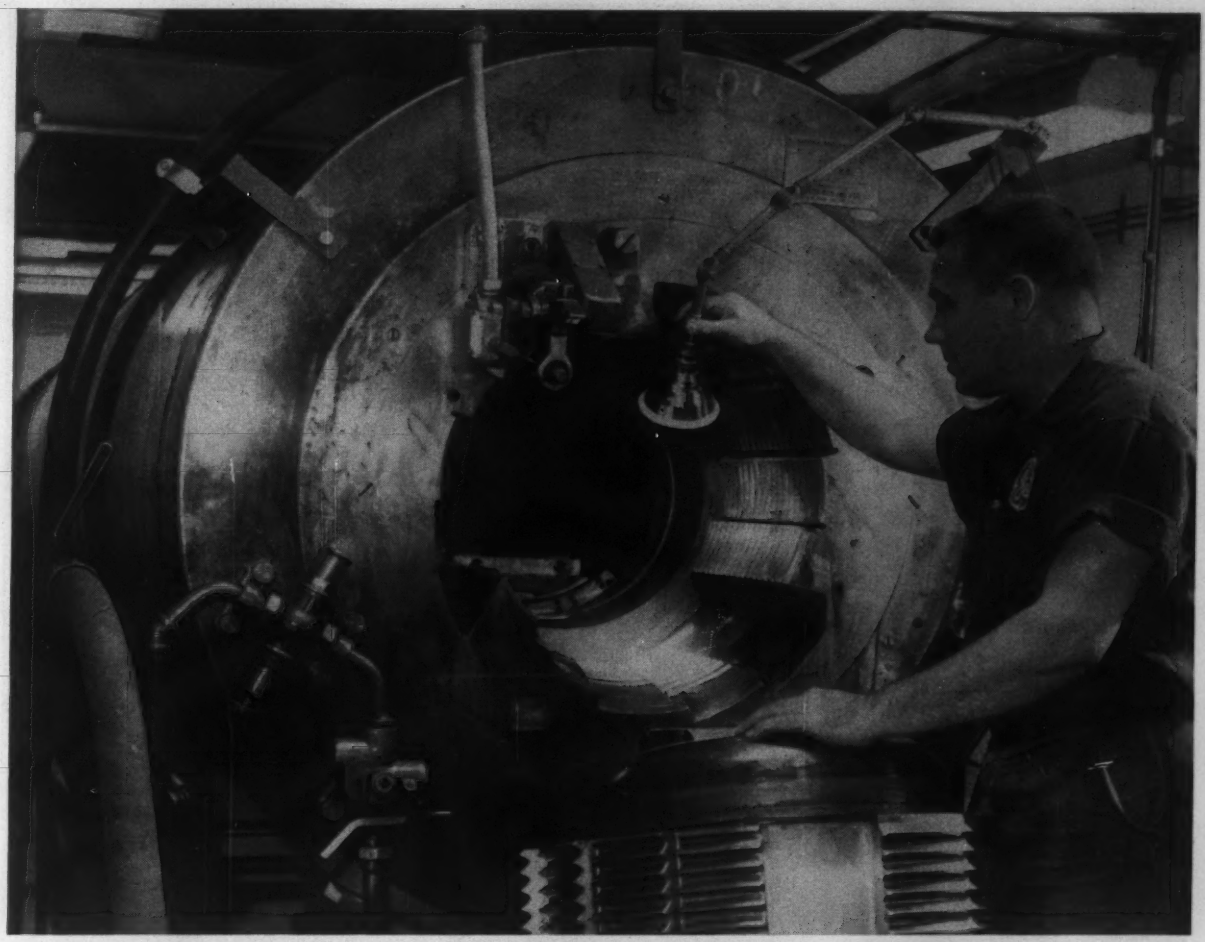
The reason, according to the Malleable Founders Society, is that pearlitic malleable has an unusual combination of good machinability and superior response to hardening.

Results of service test runs under loads of 415 lb were: 1) gray iron gear teeth flaked off after 10 hr; 2) nodular iron teeth were rolling and mushrooming after 12 hr; 3) pearlitic malleable teeth showed no wear after 72 hr.

Gears Induction hardened

Grade 60003 pearlitic malleable is used. Although its Brinell hardness is in the 197-241 range, the presence of temper carbon nodules makes it as easy to machine as gray irons in the 160-193 range.

After the teeth are cut, the gear surface is induction hardened. The iron contains between 0.3 and 0.9% combined carbon which contributes to the final Rockwell hardness of 55C and above after treatment.



BATTLESHIP GUN BARREL RE-ENLISTS AT GENERAL ELECTRIC

Molybdenum Electrodes. This pair of 12″ diameter electrodes—from the G-E gun barrel—will be used for consumable electrode vacuum arc melting.

This 16″ gun barrel, from the scrapped U.S.S. Colorado, has a Space-Age job—at General Electric in Cleveland. It's now a hydrostatic pressure chamber, used to cold-form massive pieces from tungsten and molybdenum powder.

PS (for pressed and sintered) Moly and PS Tungsten, and their alloys, are new G-E products, important in today's defense effort and civilian markets.

Here are three ways to use PS powder metallurgy billets, slabs, tubes or preforms made from these refractory metals:

1. Forging and metalworking. Use PS Moly and PS Tungsten in billet and slab form for sheet rolling or forging. High densities: moly 95% minimum, tungsten 92% minimum.

2. Consumable electrode vacuum arc melting. Use electrode bars of moly in diameters 1″ through 12″. Tungsten and moly/tungsten alloys, 1″-9″. High density and high purity (99.9% minimum metal content). Good straightness—no more than 3/16″ camber on a 30″ electrode. With or without carbon additions.

3. Direct machining. For example, crucibles, furnace boats and throat inserts for missiles are machined from PS Tungsten preforms. Order the basic PS material for your own machining or, should you prefer, order the finished part ready to use. If you're looking for controlled density in tungsten, General Electric can vary it between 65% and 95%, plus or minus 3%.

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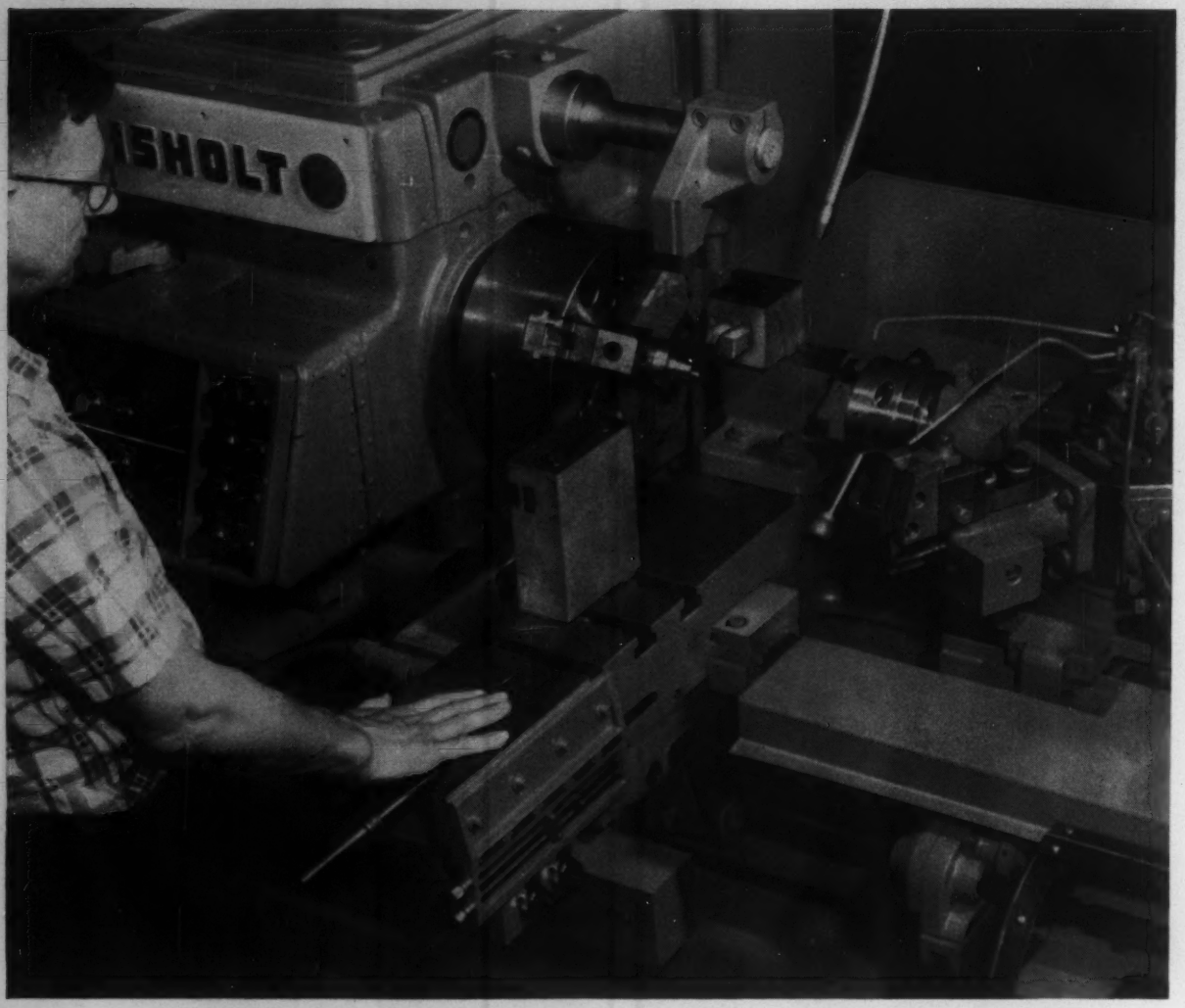

Automatic cycling Gisholt 5AR handles variety of bar and chucking tasks, depends on nickel alloy steels for resistance to heavy stress and wear.

Three nickel alloy steels give Gisholt 5AR extra strength for precision metalworking

Here's where Gisholt engineers specify nickel steels to insure close-tolerance machining with the MASTERLINE* 5AR Turret Lathe:

Chuck screws are made of **AISI 3312** carburized to a case depth of .015" and hardened to 60 Rc min. This 3½% nickel steel resists chipping or breakage when the screws are tightened by hand or hammer. The strength and toughness of AISI 3312 steel well match the severe torsional and compressive loads that are brought to bear as the workpiece is locked in place and machined.

Headstock gears in the 5AR lathe are **AISI 4620** carburizing steel (1.8% nickel). Readily heat-treated to a surface hardness of 60 Rc, 4620 develops average core properties of 135,000 psi tensile strength and 105,000 psi yield strength. Gears made of this steel survive the highest tooth loads and abrasive wear.

Spline shafts are made of **AISI 4340.** This 1.8% nickel through-hardening steel provides excellent strength in an extremely tough core for shafts subject to high torsional stresses. Oil-quenched and tempered to a tensile strength of over 200,000 psi, AISI 4340 develops consistent strength and toughness in parts having varied section size.

When you design, order or use heavily stressed parts for machine tools, count on the strength and toughness of nickel alloy steels. And for engineering data on these steels to help you select the best combinations of case and core properties, write to Inco. We'll be glad to help. *Reg. trademark

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(cont'd from p 19)

What's new IN MATERIALS

New Coating System for Underground Couplings

■ A new coating system developed by Dresser Mfg. Div., Dresser Industries, Inc., Bradford, Pa., eliminates costly and difficult field coating of couplings for underground pipe. The system has been in service for over 2½ years; its success may open up a new approach to corrosion protection of other buried metal structures.

Developed after ten years of research, the new system provides protection by means of three layers:

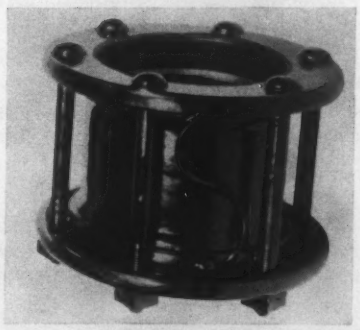
1. A corrosion resistant base shopcoat of thermosetting phenolic resin (Red-D-Shopcoat). The coating is applied in a thickness of 1 to 2 mils and is dull and rust-red in appearance.
2. A heat curing coal tar epoxy coating of 3 to 5 mils.
3. A ⅛-in. final coat of hot, coal tar enamel which, through carefully controlled heating and timing, simultaneously cures the phenolic and the epoxy coatings into a tightly bonded layer and provides a thick outer shielding.

***Peel tests** show how new coating system (left) remains intact after attempt is made to pull it away. Ordinary coal-tar system (right) easily separates.*

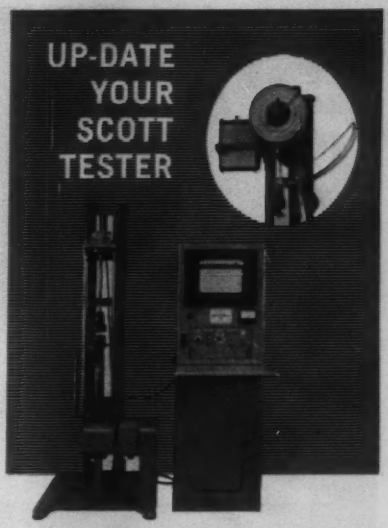
New coupling design

The coating system is intended for use with a newly designed coupling which does not have to be disassembled before use. The coupling is made in such a way that pipe ends to be connected can be simply "stabbed" into the ends of the coupling. Thus, the factory-applied coating is not disturbed when the coupling is fastened in the field.

Because ordinary couplings have to be taken apart before use they cannot be provided with an integral coating system at the factory. Such couplings can only be coated in the field after they have been completely assembled and the pipe attached. Proper cleaning of coupling surfaces in the field is difficult, and cold-applied paints and enamels, in addition to being difficult and costly to apply, have relatively poor corrosion resistance and mechanical properties. Simi-



***Coating system remains intact** after pipe is attached because of special coupling design whereby pipe is "stabbed" into coupling ends, thus eliminating coupling disassembly.*



Low Cost ACCR-O-METER Conversion Kit gives you ultra-precise electronic testing—is adaptable to all Scott Tester Models in J and L Series, and Model X-3 and XL Testers.

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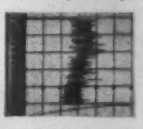
PUSH-BUTTON SIMPLICITY Fingertip controls — effortless operation. Available with wide range chart speeds . . . plus "time-to-break" and "pipping" circuit for special testing. More tests per hour, in the lab, or on production!



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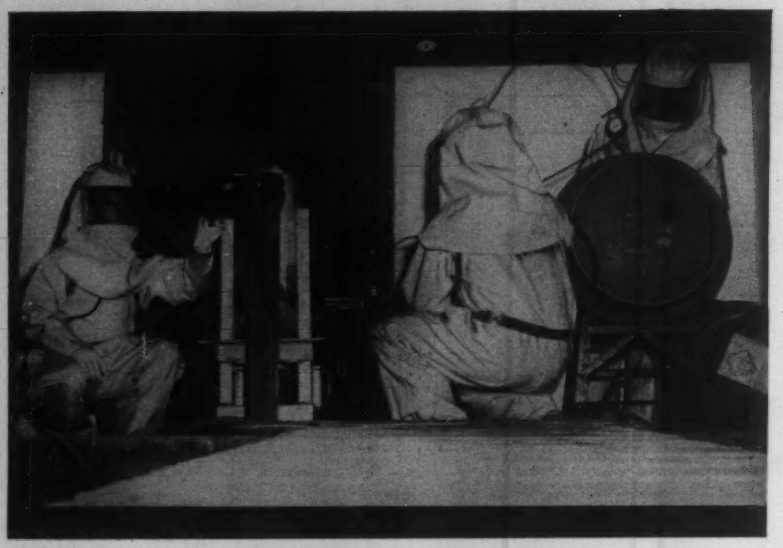

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larly, handling hot tar in the ditch is expensive, time-consuming and potentially dangerous. Also, it is difficult to apply the coatings evenly to all parts of the coupling.

KEY NO. 610

Urethane Foam Sheets Used to Insulate, Seal

Three new entries in the fast-growing foamed plastics field are two rigid urethane foam sheets and a flexible urethane foam sheet.

Flexible foam sheet

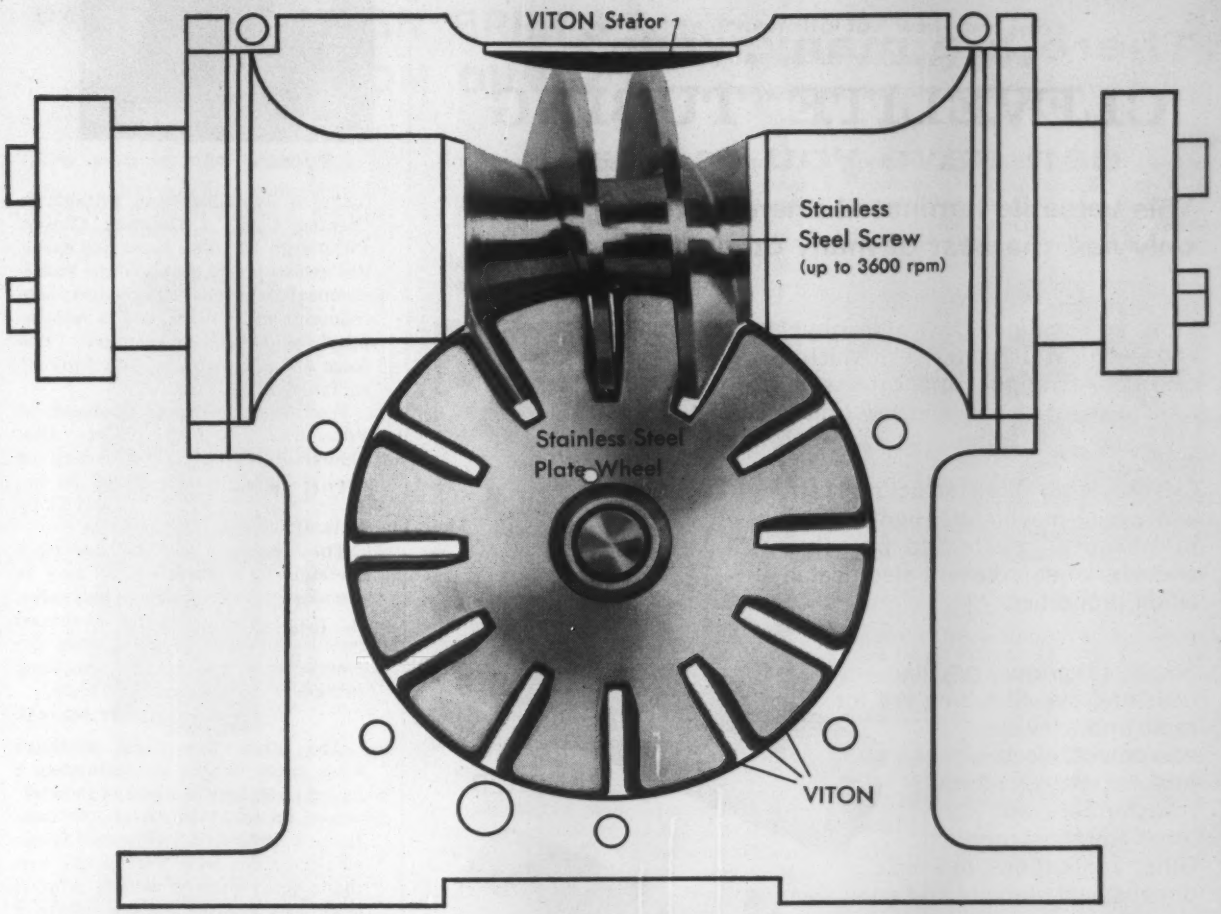
The flexible urethane foam sheet is supplied with an adhesive backing and is available from Air-O-Plastik Corp., Union City, N. J. The company says weather stripping is now the biggest market for the self-adhesive foam sheet. Potential applications include gasketing, case liners, display items, teaching and lecture aids, dust seals in television sets, sound deadeners under automobile hoods, insulation in computers, gasketing in electronic equipment, and packaging for air guidance systems. KEY NO. 611

Rigid foam sheets

The two rigid urethane foam sheets are designed primarily for use as thermal insulations in freezers, refrigerators, ducts and pipes. One of the sheets, called Foam-

Pittsburgh Corning Corp.

***Workmen** apply blocks of cellular glass over sheets of new rigid urethane foam to insulate cold storage warehouse.*



Durable VITON® helps solve corrosion, heat problems in design of new pulseless pump

A new twist on the 2000-year-old Archimedean screw principle has resulted in this unique positive-displacement pump, designed to handle highly viscous liquids and slurries containing abrasive and crystalline particles, without damage to crystals.

The key to the efficiency of this Goodyear* pump is the VITON-bonded plate wheel (see diagram). The slots are edged with durable VITON, which not only prevents galling, but exerts a squeegee wiping action that keeps "problem" liquids moving at full flow, without foaming or agitation.

DuPont VITON was chosen for this application because of its exceptional resistance to corrosive chemicals and oil at high temperatures. No ordinary elastomer—natural or synthetic—could stand up to the corrosive attack while maintaining a positive seal at rotor speeds up to 3600 rpm.

Do you have a design problem that might be solved by VITON's unique combination of properties? To receive more detailed information, just mail the coupon below.

**A product of Goodyear Pumps, Inc., New York, N. Y.*

DU PONT VITON® SYNTHETIC RUBBER

Better Things for Better Living . . . *through Chemistry*

E. I. du Pont de Nemours & Co. (Inc.)
Elastomer Chemicals Dept. MDE-8
Wilmington 98, Delaware

Please send me your FREE booklet that contains technical data about VITON synthetic rubber.

Name_____ Title_____

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City_____ Zone____ State_____

For more information, turn to Reader Service card, circle No. 349

There are many ways
CLEVELITE* TUBING
can save you money!

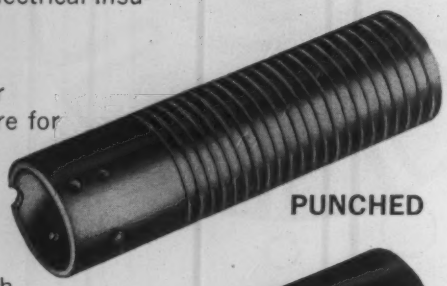
This versatile laminated phenolic tubing is often only *half the cost* of many other materials!

Clevelite *combines* desirable physical and electrical characteristics which suggest a broad range of applications where tubular construction and low unit cost are important factors.

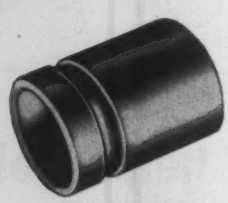
Clevelite is very light, structurally strong and easily machined. Highly resistant to moisture, unaffected by solvents and oils, it has excellent electrical insulation properties.

SAWED

Some of the more popular uses of Clevelite tubing are for radio and television equipment, electric motors, relays, controls, transformers, and many other electrical products. Other applications, in which dimensional stability and good wearing qualities are required include paint rollers, bobbins, housings, pre-forms, cores, spacers and sleeves.



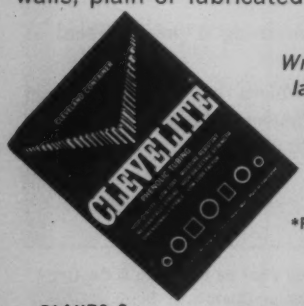
PUNCHED



MACHINED

Clevelite is produced in seven grades, round or rectangular, with thin or heavy walls, plain or fabricated.

DRILLED



Write for latest Clevelite brochure

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ABRASIVE DIVISION at CLEVELAND, OHIO

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CANADA: PAISLEY PRODUCTS CO. LTD. 36 UPTON RD., SCARBOROUGH, ONT.

For more information, turn to Reader Service card, circle No. 361

thane, is available from Pittsburgh Corning Corp., 1 Gateway Center, Pittsburgh 22. The foam has excellent resistance to gasoline and petrochemicals which dissolve polystyrene foams. It will not rot, and is vermin-proof, odor-free and nontoxic. The foam has a k factor of 0.14 Btu/hr/sq ft/°F/in.

Foamthane is being produced at Pittsburgh Corning's Port Allegheny, Pa. plant in a variety of sizes including sheets 24 by 36 in., 12 by 36 in., 12 by 72 in., and 24 by 72 in. Thickness: ½ to 15 in.

The company says the new rigid urethane foam sheet can be used in combination with its Foamglas cellular glass to combine the structural stability of cellular glass with the compactness and high insulating efficiency of rigid urethane foam.

KEY NO. 612

The other new rigid urethane foam sheet weighs approximately 2 lb per cu ft and is supplied in thicknesses up to 11 in. Available from Barrett Div., Allied Chemical Corp., 40 Rector St., New York 6, the urethane foam sheet is said to offer at least 50% greater thermal efficiency than other types of insulation of equal thicknesses. The sheet can be applied directly to a variety of metal and nonmetallic surfaces with hot asphalt and other types of adhesives. It is dimensionally stable, with extremely low shrinkage and expansion factors. The new foam sheet does not absorb water and is said to maintain consistently low vapor permeability. It has a k factor of 0.15 Btu/hr/sq ft/°F/in. at 70 F.

KEY NO. 613

Two Electrodes Join Manganese Steel

Two new welding electrodes for joining austenitic manganese steel to itself and to carbon, stainless and low alloy steels have been introduced recently. The electrodes are also designed for build-up applications.

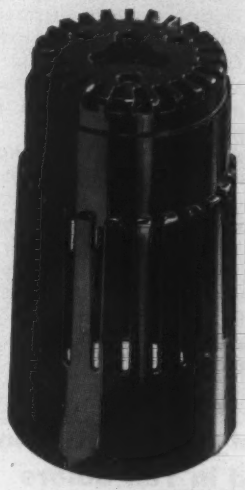
Hardalloy 120 is available from McKay Co., 1005 Liberty Ave., Pittsburgh 22. The producer says Hardalloy 120 deposits have a controlled ferrite level of approximately 12%, providing good crack resistance. The new electrode is said to be an excellent build-up material because of its

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **Phenolic for wet-dry jobs**
- **Plastic in subway cars**
- **Structural adhesives**

Are you in hot water?

This washing-machine component has three jobs to do. It filters out lint from the wash load, adds detergents and



PHILCO CORPORATION

bleach powders to the wash water, and dispenses clothes conditioner or water softener into the rinse water.

Design of the part clearly indicated molded plastic for economical production. But it was essential to have a plastic that would stand long exposure to moisture, heat, and detergents, and provide a good-looking surface.

That's why *Durez 13856 Black* was selected. This flock-filled phenolic molding compound is especially formulated for parts in contact with water. It's widely used in pumps and valves—particularly when a part is to be wet on the inside and dry on the other. It has excellent resistance to detergents, acids, soaps, mild alkalies, and many solvents. Hot, sudsy water can't harm it. In addition, the material has the inbuilt ruggedness and durability of all phenolics—and is relatively low in cost per lb.

Light – and tough

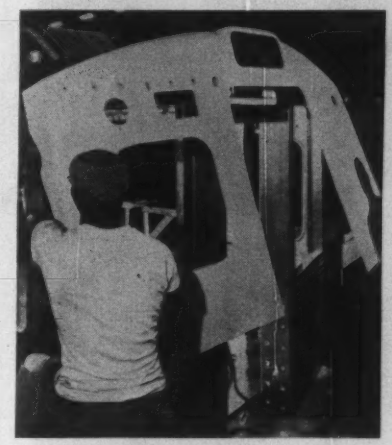
Philadelphia expects to save $6.5 million over the 35-year life span of its 270 new subway cars.

Built of stainless steel and with one-piece end sections of glass-reinforced Hetron® polyester, the new cars save on power because they weigh about three tons less than conventional cars.

They won't ever need painting. End sections are dentproof and virtually shatterproof. The Hetron material retards fire, and corrosion isn't expected to be a problem.

Ends of the cars were made by hand layup at Modular Molding Corp., which delivered the first unit just one month from start of tooling. Section thickness and rigidity were controlled by adding extra plies of fibrous glass where needed during layup. Gray metallic color was molded in.

Hetron is tough enough for just about any structural assignment you want to give it. Inherent fire safety—



THE BUDD COMPANY

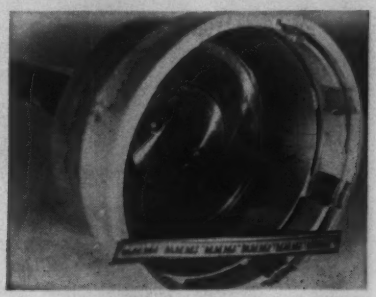
without loss of other physicals—qualifies it for many jobs other polyesters can't do. If you'd like facts on what's being done with Hetron today, just check the coupon.

Strong stickum

Are the old ways of joining metal and metal good enough for you? Then prepare for a mild shock as you look at this picture.

It's the housing of an automotive torque converter, joined to the output shaft by a thin film of thermoset cement. The converter has just undergone torsional tests that wrecked its mechanical parts—with no effect whatever on the metal-to-metal bond. Loud applause for the Cycleweld Chemical Products Division of Chrysler Corporation for this prodigious bond!

A similar cement, made of nitrile rubber and Durez phenolic resin, cut



CYCLEWELD CHEMICAL PRODUCTS DIVISION
CHRYSLER CORPORATION

the cost of assembling an all-aluminum truck tailgate from $15.18 to $1.75, by eliminating 211 rivets and 42 welds.

Other heat-setting cements show promise for:

- Building new strength and quietness into car doors, deck lids, and hoods by edge-bonding instead of tack welding.
- Attaching metal trim without drilling holes.
- Easy-to-cast aluminum engine heads and intake manifolds, made in two sections bonded together with a leak-proof, heatproof seal.

We don't make these super-stickers ourselves. We merely supply the phenolic resins that give them many of the qualities a good structural adhesive must have, including permanent rigid set and heat resistance. If you'd like to know where you can get adhesives made with our resins, we'll be glad to tell you.

For more information on Durez materials mentioned above, check here:

- ☐ *Durez 13856 Black* phenolic molding compound (4-page bulletin)
- ☐ Hetron fire-retardant polyesters (designer's data file)
- ☐ "Durez Plastics News" (a review of current plastics applications, mailed bimonthly)

Check, clip and mail to us with your name, title, company address.

DUREZ PLASTICS DIVISION

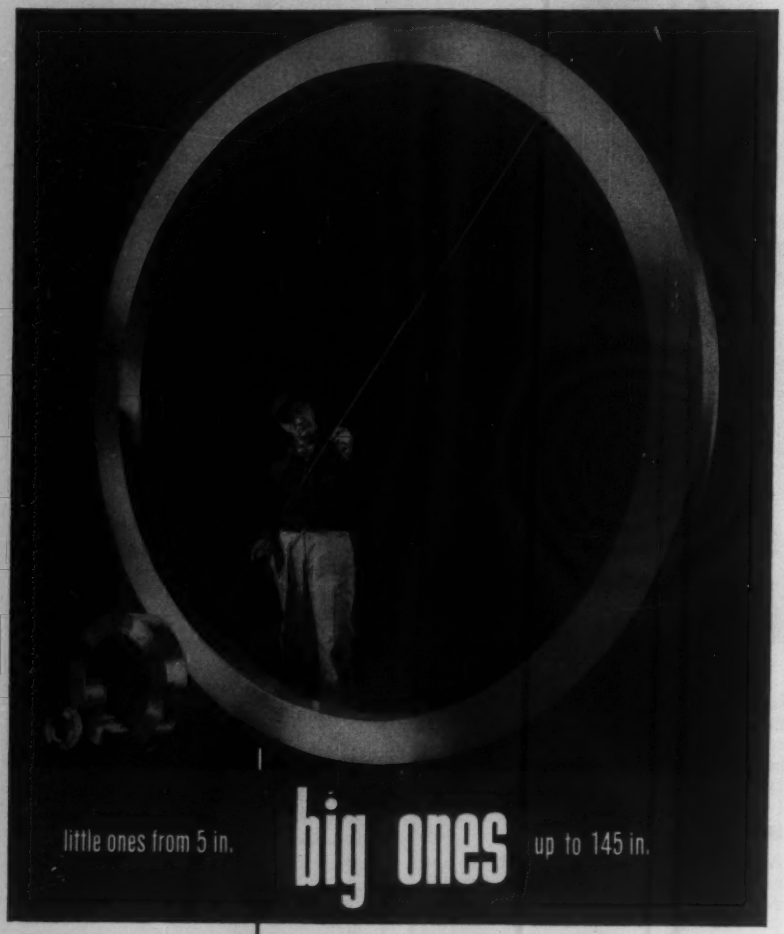
1408 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

For more information, turn to Reader Service card, circle No. 338

How to buy steel rings . . .



consult with experienced maker

Find out about his background . . . experience . . . manufacturing facilities . . . how close he can come to meeting your specifications . . . what engineering assistance he can provide.

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When you have found this experienced, reliable supplier, send him your drawings. Give him complete details on materials, shape, tolerances you require, nature of application, and the performance you expect.

then let him assist you

If Edgewater is your choice, you will find that we will follow your specifications exactly. If required, we can furnish engineering assistance and suggest the material, shape and size to give you the ultimate in performance and economy.

want more details? Write for the Edgewater brochure, which describes our facilities, know-how, and range of sizes and shapes.

Edgewater Steel Company

For more information, turn to Reader Service card, circle No. 398

high compressive strength and its ability to withstand repeated impacts with minimum deformation and no cracking. The electrode has good corrosion resistance at temperatures up to 1000 F. It is supplied in sizes from ⅛ to ¼ in. in dia and in 14-in. lengths.

KEY NO. 614

Build-Bond is available from Rexarc Inc., West Alexandria, Ohio. The electrode has a mineral coating that forms a smooth, self-relieving slag that brushes away easily. Deposited hardness ranges from Rockwell B75 to B85, but work hardens to Rockwell C45. The electrode is supplied in sizes from ⅛ to ¼ in. in dia.

KEY NO. 615

Heat Resistant Paint Sold in Ten Colors

A heat resistant paint is now available in ten standard colors. The paint, called Extra High, is said to withstand temperatures up to 1700 F without blistering or burning. It is marketed by Chem Industrial Co., 3784 Ridge Rd., Brooklyn 9, Ohio.

The paint consists of a clear silicone base blended with a special aluminum pigment. It air dries to a bright finish in approximately 30 min. The dry coating is said to have good resistance to moisture, mild acids, alkalis and industrial fumes.

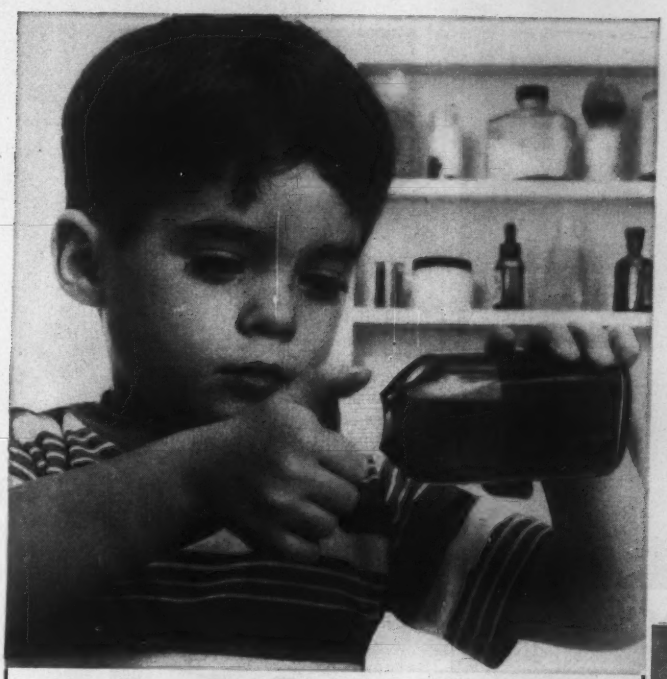
The paint is expected to be used on heat lines, ovens, compressors, engine heads, mufflers, radiators, stoves and exhaust manifolds.

KEY NO. 616

Acrylic-Glass Panels Are Weather Resistant

Fiberglass-reinforced acrylic panels for housings, partitions, siding and skylights have been introduced by Owens-Corning Corp., Toledo, Ohio.

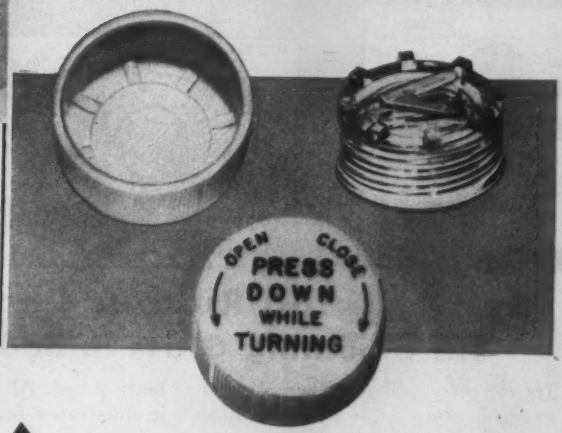
The translucent panels are said to be the first to use 100% acrylic resin as the bonding agent. The resin gives the panels excellent resistance to all kinds of weathering and provides good light diffusion. In outdoor weathering tests in Florida, the panels showed no visible change after three years' exposure. And after a 2000-hr Weatherometer ex-



NEW DESIGN WITH TWO PLASTICS ...A CHILD-SAFE BOTTLE CAP

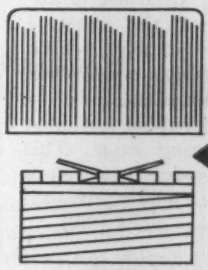
Two BAKELITE® Brand plastics work together in a totally new, much-needed cap for medicines

97% of pre-school children tested couldn't open this bottle cap—Since hundreds of young children are poisoned every year by medicines taken accidentally, this percentage is significant. According to the manufacturer, Brockway Glass Company, the safety cap, which looks like a conventional bottle cap, is "the first major improvement in prescription packages in fifty years." Unique in design, it must be pressed down and turned to open—operations that children five and under can rarely perform simultaneously. For them, the cap turns freely without unscrewing from the bottle.



Keep an eye on packaging—it's one of the liveliest areas of design and a source of refreshing ideas. Not only must it keep pace with changing esthetic concepts, but it also involves practical mechanics. This is often the reason why packaging designers have made such bold use of plastics in working out their plans. Plastics can provide properties that differ from those of conventional materials. And since there are differences among plastics, the range of possibilities is far-reaching.

Under the BAKELITE Brand, for example, you can select from five different classes of plastics to fit your needs—polyethylenes, epoxies, phenolics, styrenes, and vinyls. Molded, extruded, laminated, and in coatings, they can be a source of genuine product improvement. And from Union Carbide, you can get expert technical assistance in putting them to the best use. For information, see Sweet's Product Design File, section 2a/ui.



Two plastics help make this design workable—Manufactured for the Brockway Glass Company by Seals, Inc.,* the new safety cap consists of two parts—an outer shell molded of BAKELITE Brand high-density polyethylene, and an inner section molded of BAKELITE Brand C-11, an acrylonitrile-styrene copolymer. There are multiple advantages to this combination—eye appeal, low cost, resistance to chemicals and stress cracking, and durability. The toughness and resilience of both these materials are important mechanical features. Lugs on the inner cap engage those inside the outer cap when pressure is applied. Without pressure, the two leaf springs molded on the inner cap keep lugs from engaging, and the outer cap turns without opening.

Molded details in two tough materials are key to function, low cost—Both the BAKELITE high-density polyethylene and the BAKELITE C-11 plastic used in the cap have a degree of "give"; they are neither brittle nor soft. It is this factor that makes the lugs disengage unless pressure is applied, and it also means that the lugs will not break off or wear down with repeated use, as might happen with a brittle material. The list of molded-in details is impressive—screw thread, lugs, leaf springs, printing, knurling—yet all are readily formed in these plastics with a simple, economical molding operation.

*U.S. Patent No. 2964207

UNION CARBIDE

Dept. JM-85H, Union Carbide Plastics Company
Division of Union Carbide Corporation
270 Park Avenue, New York 17, N.Y.

Please send me information on the use of BAKELITE Brand Plastics in design with particular emphasis on these properties_____.
Application being considered is_____.

NAME_____

FIRM NAME_____

STREET_____

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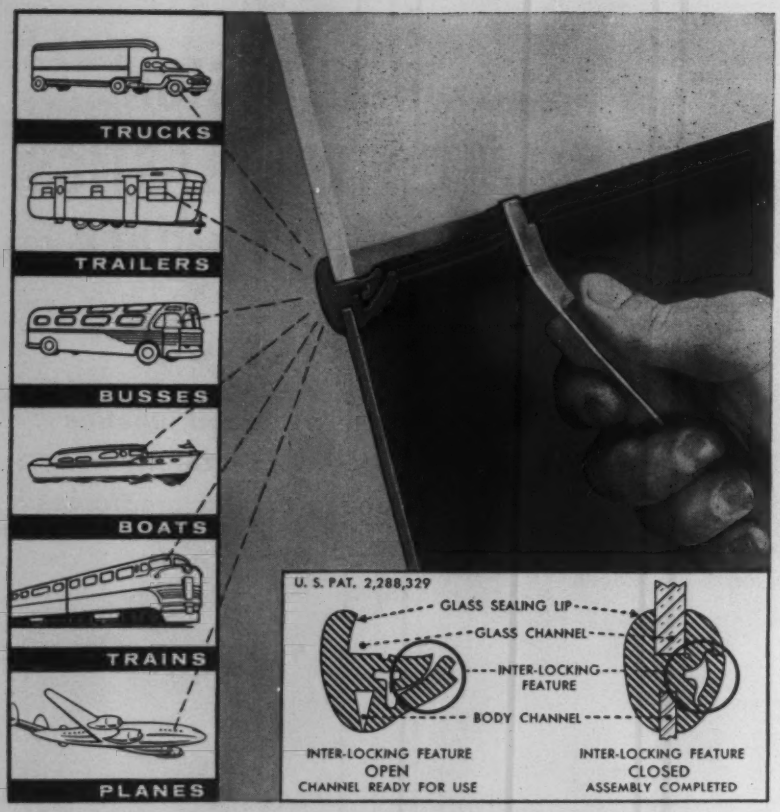
BAKELITE and UNION CARBIDE are registered trade marks of Union Carbide Corporation.

For more information, turn to Reader Service card, circle No. 320



Self-Locking Rubber Channel for Mounting Glass in Body Panels

Its *one-piece* design locks and seals in one operation. No extra locking-strip needed. It's the faster, simpler method for mounting glass in any type body panel—truck, trailer, bus, boat, train, plane, etc.

Extruded with inter-locking feature at direct right angle to body, the Continental Channel permits unhampered insertion of glass. Locking tongue is pressed into its matching groove which forces the lips against *both* the glass and body panel—a more positive seal with exceptional push-out pressure.

Compounded for maximum weather resistance and extra long life. Close durometer tolerances are held for uniformly tight seal against moisture and surest possible locking. These rubber channels can be positioned first on *either* glass or body panel. All details are shown in illustrated brochure gladly sent on request.

Ordered and re-ordered by the most prominent body builders, this Self-Locking Channel is another example of the creative thinking and ingenuity behind rubber parts by Continental. When you need rubber parts to do a specific job, call a rubber specialist *during the planning stage.* This often makes for economy as well as better end results. Call Continental —rubber specialists since 1903.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

CONTINENTAL RUBBER WORKS • 1985 LIBERTY ST. • ERIE 6 • PENNSYLVANIA

For more information, turn to Reader Service card, circle No. 436

what's new IN MATERIALS

PROPERTIES[1] OF ACRYLIC-GLASS PANELS

Glass Content (by weight), %	25
Ten Str, psi	12,000
Elong, %	1.5
Flex Str, psi	25,000
Flex Mod, 10^6 psi	0.9
Rockwell Hardness	R121
Compr Str, psi	24,000
Izod Impact Str (notched), ft-lb/in.	.6
Flammability, in./min	1.3
Dielec Const (1000 cps)	4.1
Dissip Factor (1000 cps)	0.05

posure the panels showed no change in surface gloss and no fading. Panels using conventional bonding resins and a surfacing mat showed a 35% loss of original gloss in the same test.

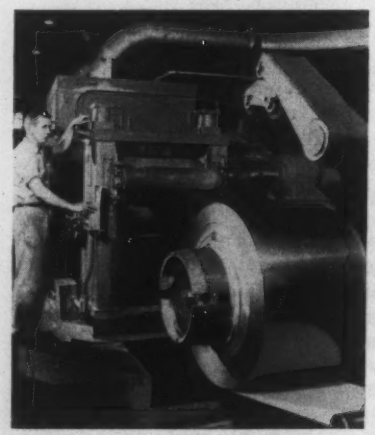
The acrylic bonding resin is combined with a heavy center ply of fiberglass reinforcing mat and with a ply of surfacing mat on each face of the panel.

The panels are supplied in four colors: frost with 80% light transmission; white and light green with 75% light transmission; and medium green with 60% light transmission.

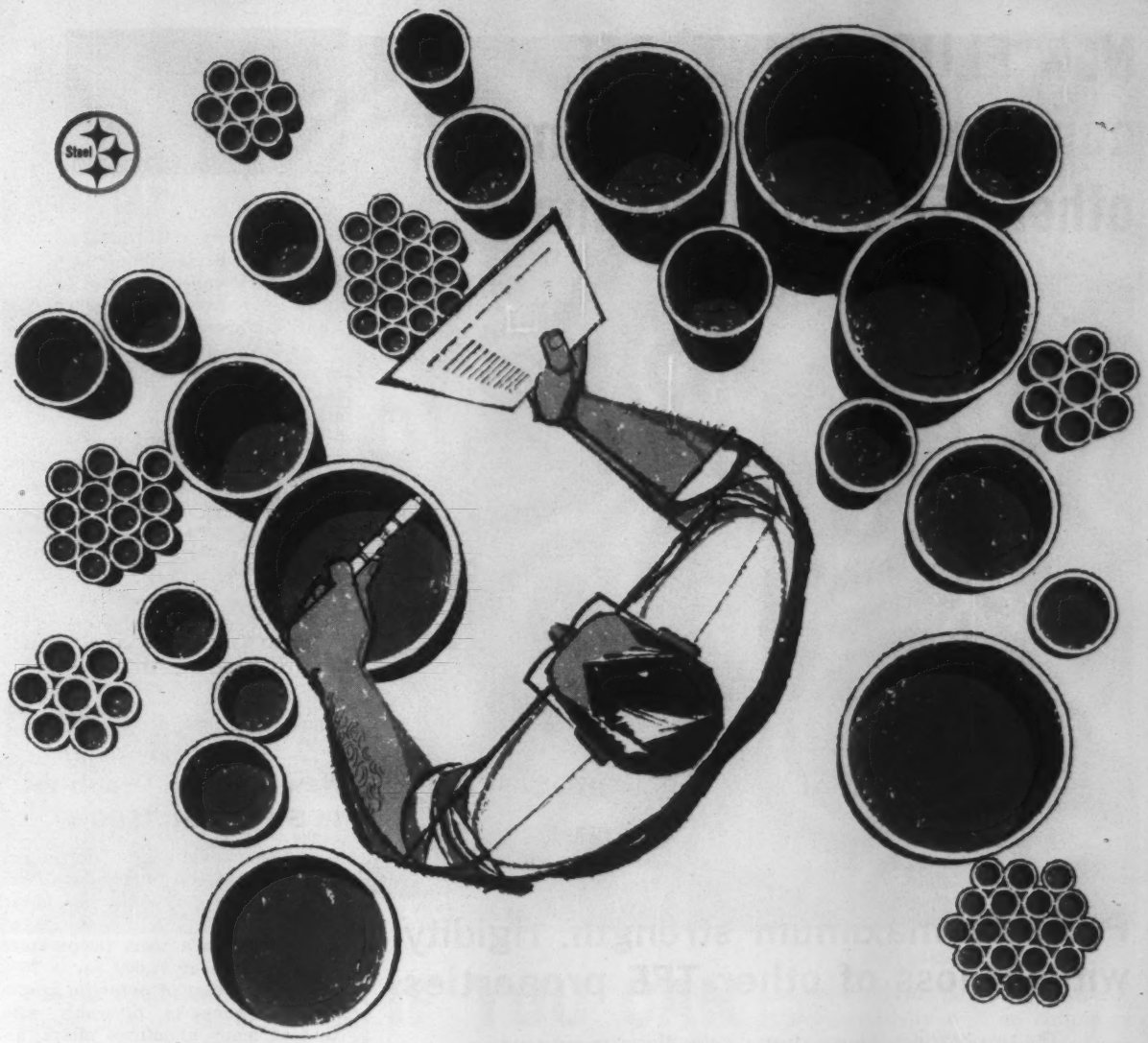
KEY NO. 617

Stainless Steel Strip Is Highly Reflective

Commercial availability of stainless steel strip with a highly reflective finish on both sides has been



***Buffing line** in use at Universal-Cyclops Steel's Coshocton, Ohio, mill turns out highly reflective stainless steel strip.*



"Fitness report" with hundreds of identical copies

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The Babcock & Wilcox Co., Tubular Products Div. ↓↑
The Carpenter Steel Co., Alloy Tube Div. ↑
Jones & Laughlin Steel Corp., Electricweld Tube Div. ↓
National Tube Div., United States Steel Corp. ↓
Ohio Seamless Tube Div., Copperweld Steel Co. ↓
Republic Steel Corp., Steel and Tubes Div. ↓↑
Revere Copper & Brass Inc., Rome Mfg. Co. Div. ↓↑
Sawhill Tubular Products, Inc. ↓↑
Southeastern Metals Co. ↓
The Standard Tube Co. ↓↑
Superior Tube Co. ↑
Trent Tube Co., Subs. Crucible Steel Co. of America ↑
Union Steel Corp. ↑
Van Huffel Tube Corp. ↓
Wall Tube & Metal Products Co. ↑
Clayton Mark & Co. ↓

↑ PRODUCES WELDED STAINLESS STEEL TUBE
↓ PRODUCES WELDED CARBON STEEL TUBE

261

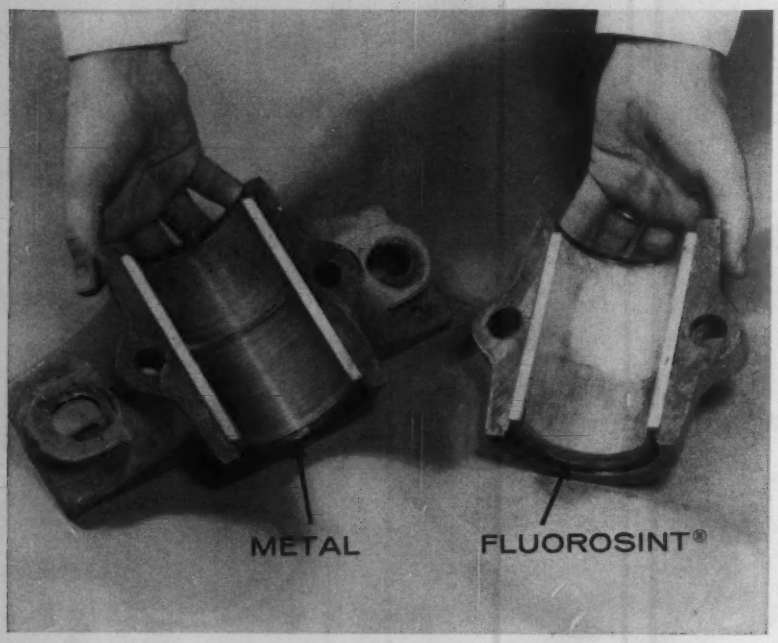
Here's the reason why you can count on welded carbon or stainless steel tubing in critical heat transfer applications: its method of manufacture, developed to high domestic standards, results in consistently reliable performance. Starting with clean, scale-free flat rolled steel the resulting tube surfaces are smooth, and free from scratches and pits. You are assured of concentricity, exact O.D. and I.D., precise wall thickness, and uniform ductility for bending or rolling in operations.

Whether you require carbon or stainless steel analyses, listed here are the quality welded tube producers ready to serve you. It will pay you to contact any of them or write for free Booklet 8591, Department MD-4, Welded Steel Tube Institute, Inc., Hanna Building, Cleveland 15, Ohio.

WELDED STEEL TUBE INSTITUTE, INC.

For more information, turn to Reader Service card, circle No. 348

New FLUOROSINT® TFE composition outwears metal, other TFE-fluorocarbons



Provides maximum strength, rigidity without loss of other TFE properties

The two bearings, above, dramatically illustrate outstanding properties of Polymer's new FLUOROSINT TFE compound. The high temperature metal bearing wore, scored the shaft and had to be replaced in three months. The replacement FLUOROSINT bearing has operated at 450°F. for more than a year with still no signs of deterioration.

FLUOROSINT, a TFE resin compounded with proprietary inorganic materials, provides maximum strength without sacrificing excellent electrical, chemical and thermal properties of TFE-fluorocarbon. It is available in a variety of economical stock shapes or can be cold pressed and sintered to close-tolerance components.

For complete information write for new illustrated Bulletin BR-9.

POLYPENCO

THE POLYMER CORPORATION

Operating Subsidiary: Hatex Corporation,

Reading, Penna.

Engineered Industrial Plastics

NYLONS • TFE-FLUOROCARBONS • OTHER PREMIUM PLASTICS

For more information, turn to Reader Service card, circle No. 442

announced by Universal-Cyclops Steel Corp., Bridgeville, Pa.

The strip, called Unibrite, is produced on a five-station buffing line which can operate at speeds of 20 to 80 fpm. The line handles coils up to 26½ in. wide. Each station has buffing heads for the top and bottom of the strip.

The in-line buffing operation is said to improve corrosion resistance of the stainless steel strip. The producer also says consistency of finish, color, shading and reflectivity are maintained on both sides of the strip and from coil to coil.

Other major stainless steel strip producers have recently installed bright annealing equipment to maintain a highly reflective finish on their strip (M/DE, Mar '61, p 192).

KEY NO. 618

New Alloyed Graphite Is Strong at 3500 F

A new pyrolytic graphite alloyed with boron is said to have high bend strength at temperatures above 3500 F.

The material's room temperature bend strength of 37,000 psi is 70% higher than that of pyrolytic graphite and compares favorably with that of many aluminum alloys, according to the developer.

The new material, called Boron Pyralloy, is available in developmental quantities from High Temperature Materials, Inc., 130 Lincoln St., Boston 35. It is supplied in the form of parts up to 5 ft high by 2½ ft in dia, and up to ½ in. thick.

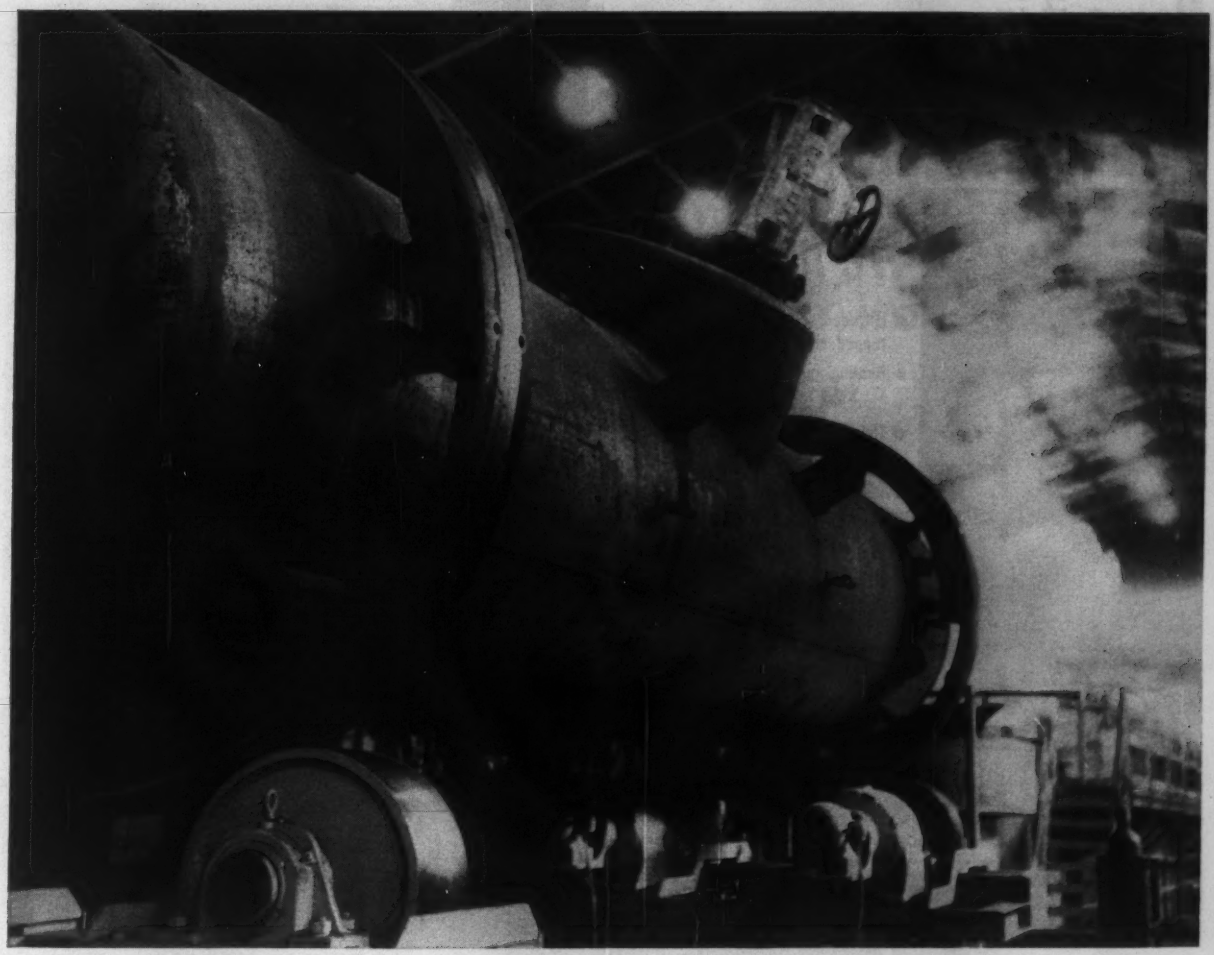
The new material is said to be harder than pyrolytic graphite, and to have better oxidation and erosion resistance.

(For more information on pyrolytic graphite, see M/DE, Feb '60, p 16, and Aug '60, p 165.)

KEY NO. 619

One-Part Epoxy Is Highly Flexible

A new one-part epoxy resin is said to be the most flexible epoxy system presently available for 310 F (formerly Class F) electrical applications. Its Shore Durometer hard-



The specialists at General American's Kanigen plant in Sharon, Pennsylvania can deposit an even coating of hard nickel alloy on most ferrous metals in common use. Regardless of how high, wide or heavy the object is, if you can get it to Sharon, we can plate its interior.

Before General American developed Kanigen coating, it was next to impossible to deposit an even nickel plating over very large surfaces or on many complex shapes. Since Kanigen nickel plating is purely a chemical process involving no electric current, it works equally well on simple or complex shapes and on small or large surfaces. Thickness uniformity of the coating is independent of part complexity or size.

IF YOU CAN SHIP IT WE CAN PLATE IT!

NO MATTER WHAT THE SIZE OR SHAPE OF YOUR PRODUCT, IT CAN BE COATED BETTER WITH KANIGEN® NICKEL ALLOY

Only General American and its authorized licensees around the world can show you how Kanigen coating may improve your product. The Kanigen process is protected by more than 30 separate patents. For detailed technical literature, write for bulletin No. 561.

Kanigen Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

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For more information, turn to Reader Service card, circle No. 336

What's new IN MATERIALS

***Parts** made of new epoxy are highly flexible and can be twisted and bent without cracking or breaking.*

ness is D18, compared to D55 for most typical semiflexible epoxy resins.

Developed and marketed by Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn., the resin is currently being used successfully in a military transformer meeting MIL-T-27A specifications at a continuous operating temperature of 340 F.

Designated Scotchcast No. XR-5029, the resin has an impregnating viscosity similar to light machine oil (150 cps) at 300 F. It has good wetting properties and has a pot life of seven days at 150 F.

Because the resin exerts little, if any, pressure on embedded parts during cure, it can be used as a void-free impregnant or encapsulant of parts with sensitive core materials or extremely fine wire, according to 3M. **KEY NO. 620**

Noted briefly in our May issue.

Aluminum-Sapphire Strong at White Heat

An experimental composite material is expected to be three to four times stronger on a pound-for-pound basis at white heat than any present high strength alloy.

Developmental work on the composite was described by W. H. Sutton of GE's Missile and Space Vehicle Dept., Philadelphia at a recent

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The new Alan Wood direct reduction plant employs the industry's most advanced technology.

From it comes Iron Powder with purity and uniformity that offers you new design flexibility . . . new fabricating possibilities . . . products of superior quality, closer tolerances at reduced production costs.

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I am interested in Iron Powder for:

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☐ Send literature ☐ Send sample

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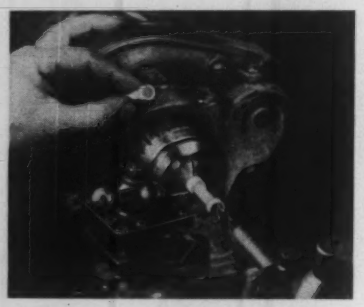
Problem: "On spec" yield of semi-conductor components drop as much as 40% within 50 cycles when using *graphite* jigs

Solution: **BORON NITRIDE** *for semi-conductor jigs*



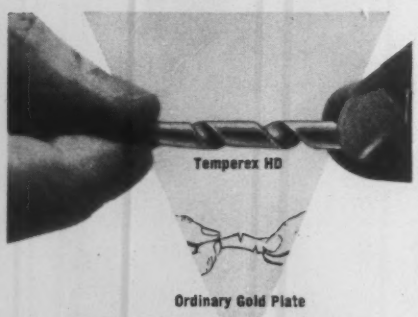
Boron nitride machines easily to close tolerances, resists chipping and retains internal jig details. It holds dimensions, has excellent release characteristics and is non-toxic.

Contact with silicon, germanium, indium, antimony, lead and other metals has little effect up to 1800 F in oxidizing or reducing atmospheres. For more information on greater yields with boron nitride, write Latrobe Plant, Refractories Div., Carborundum Co., Latrobe, Pa.

CARBORUNDUM®

For more information, turn to Reader Service card, circle No. 346

Extra High Purity Gold Plate!



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TEMPEREX HD electroplate meets or surpasses the most exacting specifications of the electronics industry. Its deposits of 99.99+ purity provide a uniformity of metallurgical characteristics never before attainable in gold electroplate.

Other advantages: 75 Knoop hardness; easy to solder or weld; and an exceptional ductility that permits *cork-screw twisting of electroformed strips without fracturing!*

Write for details.

*Patent applied for

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World's largest selling precious metal plating processes

For more information, turn to Reader Service card, circle No. 412

meeting of the American Rocket Society.

The scientist says preliminary work is being done with aluminum-sapphire composites. The final objective is to achieve a strength-weight ratio of 600,000 in. at 2000 F.

How composite is made

Sapphire whiskers are grown by heating pure aluminum to 2200-3000 F in an atmosphere of hydrogen gas containing water vapor. This causes the aluminum to evaporate and oxidize. The aluminum oxide is then deposited in the form of whiskers. The whiskers are able to withstand tension varying from a few thousand to several million psi. In size they range from tiny woolly strands to large needles.

The whiskers, sorted according to type and size, are combined with aluminum and act as a reinforcement.

The GE scientist says that several different methods of combining the whiskers with a metal body are being explored. These include: 1) impregnating molten metal with a pack of whiskers under a vacuum, and 2) mixing whiskers and powdered metal and then heating the mixture until the metal becomes molten.

Noted briefly in our May issue.

Rosin Flux Used on Wide Group of Metals

Metal surfaces normally resistant to fluxing can now be soldered with a new printed circuit flux produced by Alpha Metals, Inc., 56 Water St., Jersey City 4, N.J.

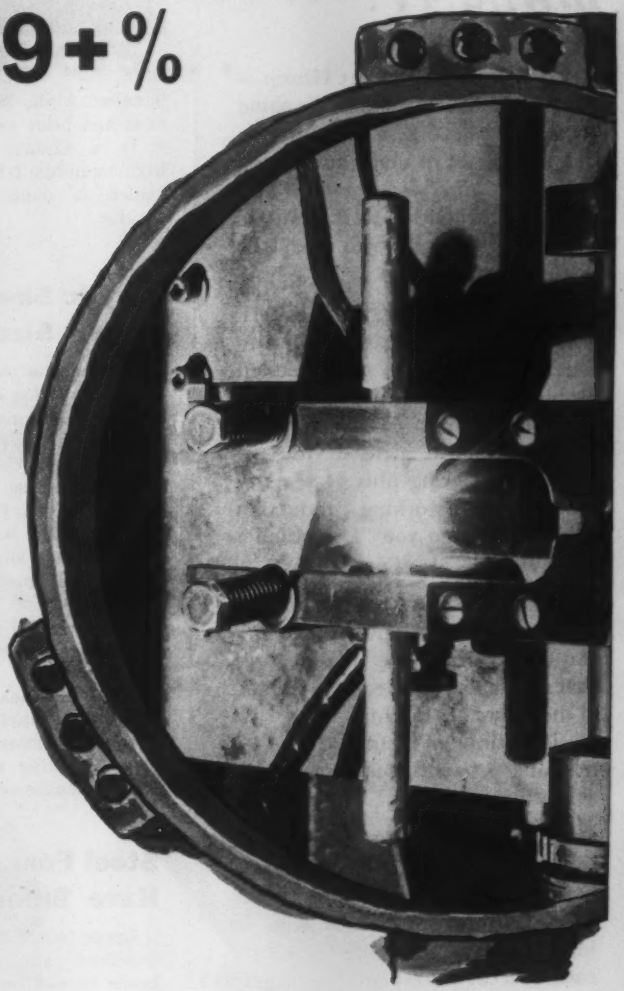
According to the producer, the flux has been found to work well with a wide group of metals, including brass, bronze, cadmium plate, copper, lead-nickel plate, silver, terne plate, hot dipped tin, electrolytic tinplate and tin-zinc plate.

A liquid rosin flux, the material

PROPERTIES OF NO. 346-35 FLUX

Density, gm/ml	0.901
Flash Point, F	78
Boiling Point, F	177
Free Acidity	None
Solids, %	35

22,500 VOLT "SEARCHLIGHT" Constantly Watches ST. JOE 99.99+% ZINC QUALITY



A blazing high voltage arc which illumines the composition of metal is part of the modern scientific equipment St. Joe uses to insure unvarying zinc purity.

Samples of every heat of St. Joe zinc are analyzed by the Direct Reading Spectrometer. The samples are placed in the Spectrometer electrode holders and the extremely high voltage creates an arc between them. As elements are vaporized, light from the arc is broken into element lines of varying light energy.

This energy, directed to photomultipliers (photosensitive electronic tubes), is converted to electrical energy which actuates precalibrated dials (see photo) that indicate elements directly IN PERCENTAGES! In five minutes the zinc sample can be completely analyzed for iron, lead, cadmium, copper, aluminum, indium, tin, antimony, silicon and magnesium. Two minutes later, casting room operators know whether or not they are holding critical purity specifications.

Stringent, continuous quality control backed by St. Joe's reputation as a supplier of quality metal is your assurance of consistent die casting results from St. Joe 99.99+% zinc.

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ST. JOE 99.99+% ZINC

ZN-190

For more information, turn to Reader Service card, circle No. 379

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Mueller Brass Co. of Port Huron is much more diversified than the name "Brass" implies . . . a lot more. In fact, because of its many and varied facilities . . . its *men, methods* and *metals* . . . Mueller is in the unique position of being able to offer true single source service.

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So, in the final analysis, no matter where you fit in the American industrial picture, whether you're making missiles or mowers... and no matter where you're located, it will pay you to LET MUELLER MAKE IT!

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PORT HURON 21, MICHIGAN

For more information, circle No. 358

What's new IN MATERIALS

is called Alpha 346-35. Its effectiveness has been proved by subjecting it to a 42-day, high temperature, high humidity trial: examination revealed a noncorrosive, insulating residue. KEY NO. 621

Acrylic Sheets Sold in New Sizes, Colors

Cast acrylic sheets are now available from Rohm & Haas Co., Plastics Dept., Washington Sq., Philadelphia 5, in two new sizes and in eight new outdoor-stable colors.

The new sizes are 8 by 12 ft and 8½ by 12 ft, in thicknesses from 0.125 through 0.500 in. Previously, the maximum size in which Plexiglas cast acrylic plastic had been available was 8½ by 10 ft. The new large sheets are supplied in standard colors as well as in the colorless transparent form.

Rohm & Haas says that the new shades are supplied as standard colors in the most widely used sheet sizes including the new extra large sheets mentioned above. KEY NO. 622

Steel Forging Ingots Have Smooth Surfaces

Large steel forging ingots with excellent surface properties are being turned out by a new casting method now in use at the Torrance, Calif. plant of National Supply Div., Armco Steel Corp.

Called Fluid Mold, the casting process uses a special slag in the ingot mold. The slag is first melted, then introduced into the bottom of the mold. As molten metal rises in the mold, the floating molten slag fills pits and cavities with a thin membrane, providing a smooth, continuous surface for the molten metal.

Ingots of stainless and tool steels weighing over 50,000 lb are produced by the method. KEY NO. 623

Ceramic Adhesive Bonds Well at 2600 F

A paste-like ceramic adhesive called Melbond CA-100 is said to have high bond strength at temperatures up to 2600 F. It is particularly well suited for bonding graphite, zirconia, alumina and other nonmetallic materials.

The new adhesive, now available from the Special Products Div. of Melpar, Inc., 3000 Arlington Blvd., Falls Church, Va., has excellent electrical properties at temperatures up to 2000 F (see accompanying table).

Parts bonded with the adhesive are air dried 1 hr at room temperature, then cured 30 min at 250 F.

KEY NO. 624

ELECTRICAL PROPERTIES OF MELBOND CA-100

Temp ↓	Dielec Const	Dissip Factor
77 F	2.12	0.0348
500 F	2.10	0.0511
1000 F	1.98	0.0227
2000 F	2.05	0.0251

Vinyl-Coated Fabrics

Quality vinyl-coated fabrics at lower costs are said to result from a new extrusion coating technique developed by Haartz Auto Fabrics Co., Newton, Mass.

Compared to other fabric coating techniques, the new extrusion method permits the use of higher molecular weight resins, produces little or no shrinkage, imposes no heat history on the cloth, and provides only moderate penetration of the fabric. The developer says fabrics coated by the method have a higher tear strength than fabrics coated by other methods since the substrates are subjected to very little heat.

The coated fabrics are supplied in a variety of colors and patterns. They are recommended for auto and chair upholstery, truck seat covers, door liners, head liners and boat covers. KEY NO. 625

DAP Compounds for Electrical Applications

Three new reinforced diallyl phthalate molding compounds have been introduced by Rogers Corp., Rogers, Conn.

RX 1260 is a flame resistant, mineral-filled diallyl phthalate compound that is free from magnetic particles. The material is said to have excellent dielectric properties after exposure to high humidity. Other features: excellent dimensional stability, good chemical resistance, and good mold-

(continued on p 181)

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Sintered metal gears, cams, special purpose filters and structural members from iron, nickel, stainless steel, brass and copper alloys are produced by Mueller for practically every segment of American industry. Whatever your product requirements are, the Mueller Sintered Metal Products Division is completely equipped to supply you with precision parts to exact specifications at substantial savings. In addition, the engineering staff, machining and finishing facilities of Mueller Brass Co. are an important plus value when you

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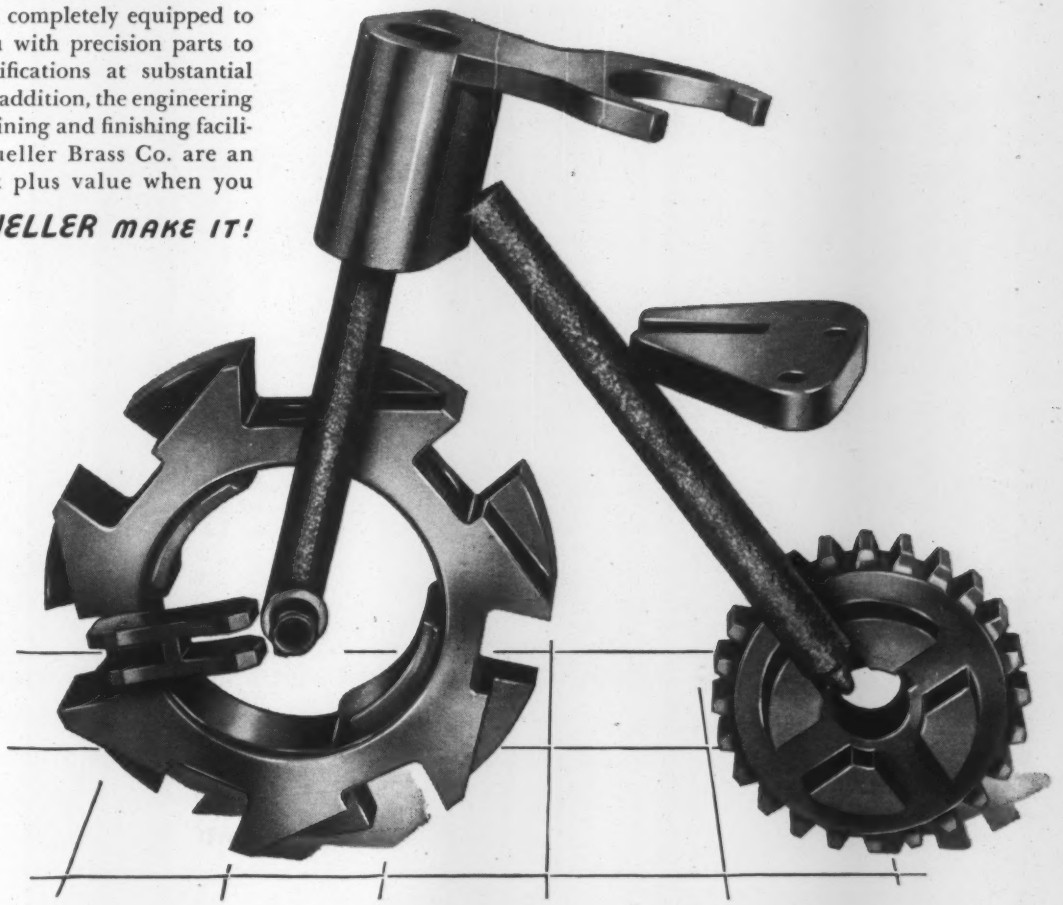

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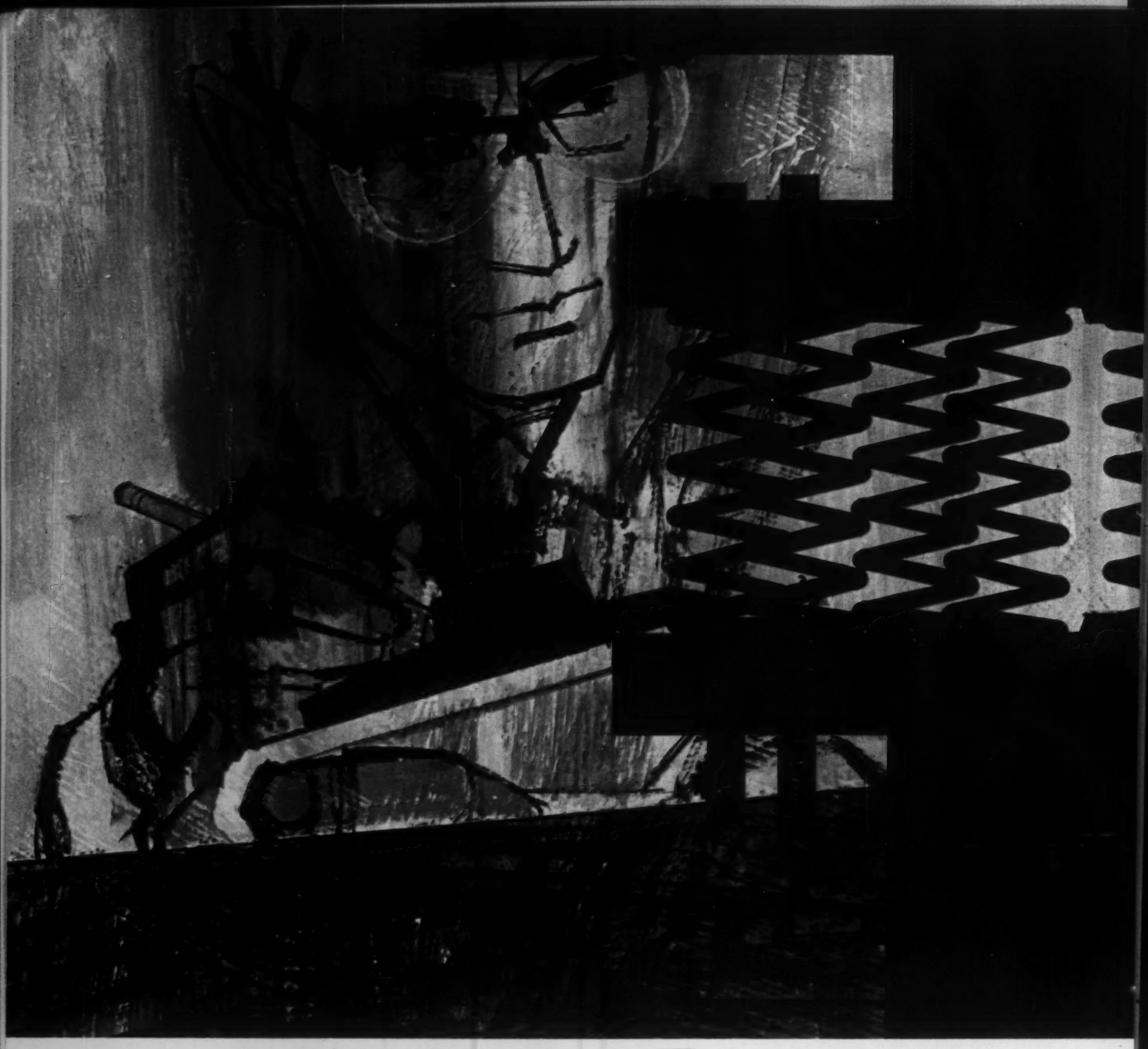


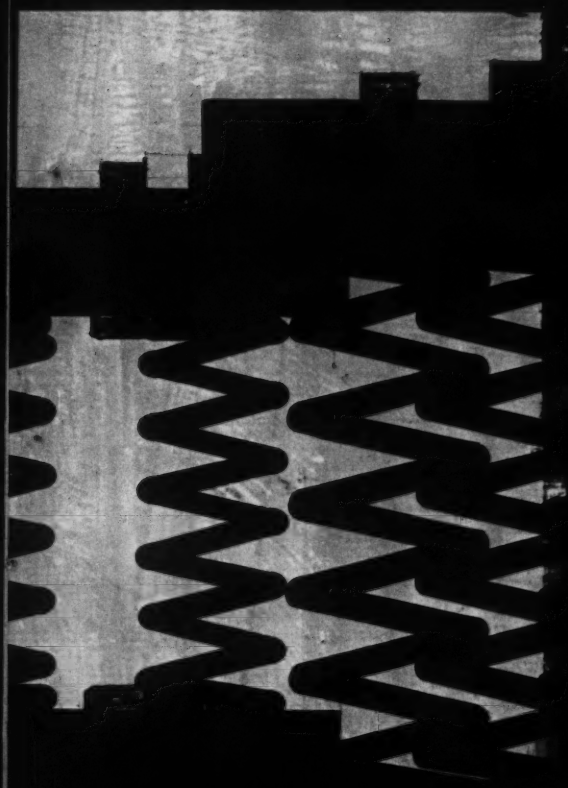
New N-S stainless wire tests 100,000 psi

From National-Standard research and development comes NS-355—a stainless steel, corrosion resistant spring wire having much greater elasticity than conventional stainless steel wire.

NS-355 is a semi-austenitic alloy, originally developed for use in heavy wire sections fabricated from bar, billet or plate stock—applications requiring corrosion resistance, strength, durability and hardness. National-Standard searched for a way to apply these outstanding advantages to highly stressed spring wire applications.

After comprehensive research in processing methods, National-Standard metallurgists developed the capability to draw NS-355 alloy into exceptionally high-tensile spring wire. Spring production tests were made on .125 and .075 inch diameter wire samples with a tensile strength over 100,000 psi higher than music spring wire, proving that NS-355 wire could be satisfactorily run on automatic coiling machines with excellent formability.

Further evaluation tests were conducted in the Spring Laboratory of Bendix Corporation, South Bend, Indiana. Here, engineers ran life cycle tests on NS-355 stainless steel springs and determined spring modulus values. On a mechanical cycling unit—eight springs to a fixture—NS-355 springs

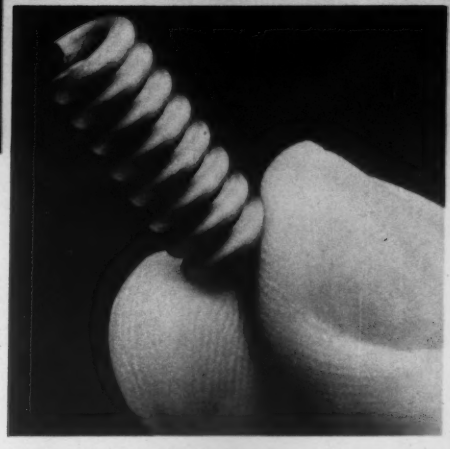


above music wire

were subjected to 600 compression cycles per minute—a total of 10-million cycles under stresses from 20,000 to 150,000 pounds.

The development of NS-355 stainless steel spring wire creates an entirely new solution to highly stressed, corrosion resistant spring requirements for jet engines, food and beverage equipment, chemical machinery and a growing number of other special wire applications.

For more information about new NS-355 stainless steel spring wire, or help in developing high quality wire to meet your special or unique applications, write National-Standard Company, Niles, Mich.



National-Standard NS-355 stainless steel springs with an index as low as 3 can be formed on automatic coiling machines without breakage.

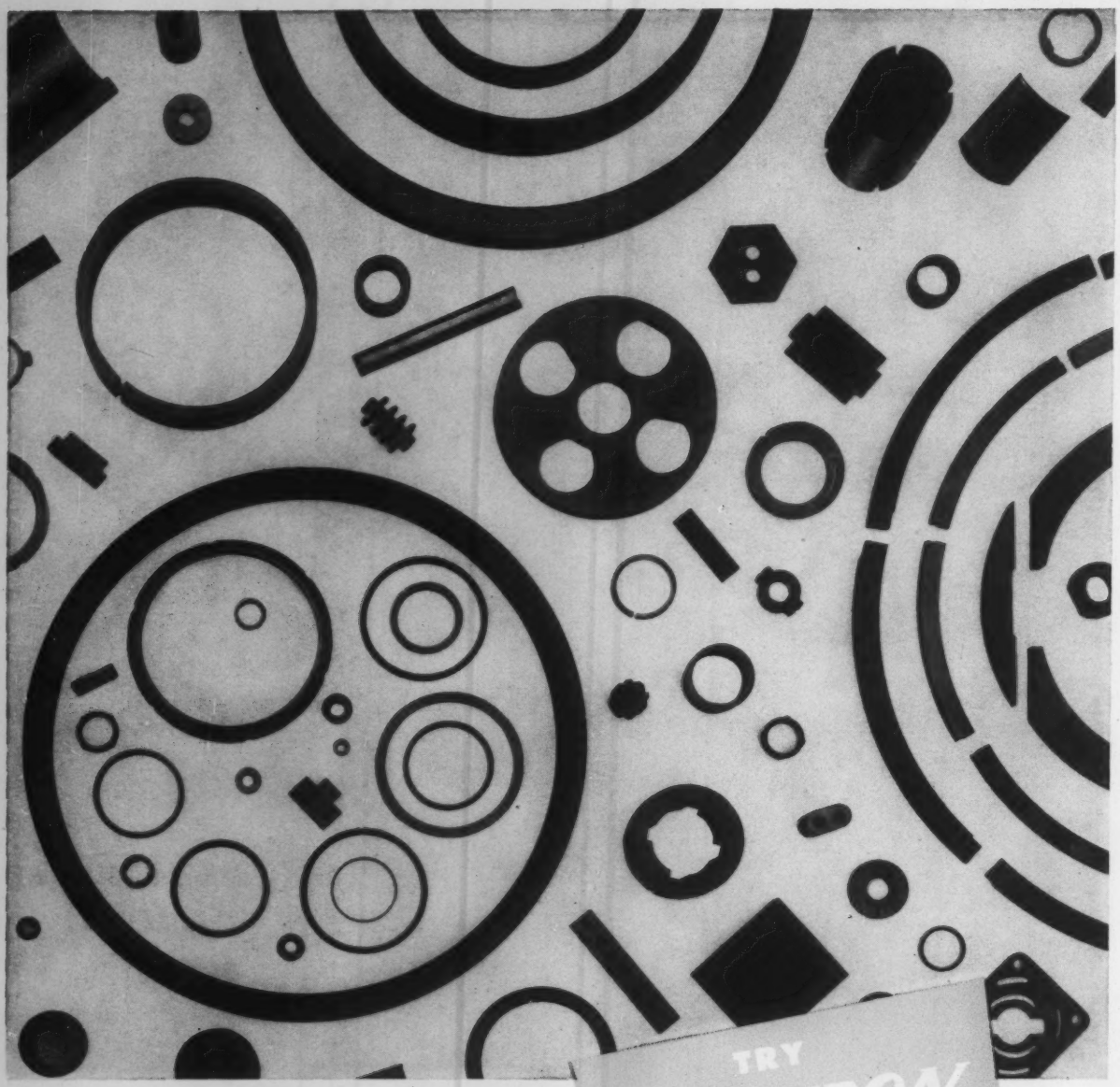
NS NATIONAL-STANDARD COMPANY

Manufacturer of Specialty Wire & Metal Products

NATIONAL-STANDARD COMPANY

Niles, Michigan

61-W03



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CHEMICAL CORROSION?

For bearings, seals, blades and similar sliding or rotating parts, try PUREBON . . . particularly if you have a problem involving high speeds . . . high temperatures . . . or chemical corrosion.

***CARBON-GRAPHITE ESPECIALLY DESIGNED FOR MECHANICAL APPLICATIONS**

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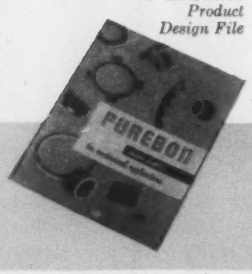
3. Stable at high temperatures
4. Light in weight
5. Readily machinable
6. Moldable to size
7. Low cost, where moldable to size

Request Catalog #60 or see Sweet's Product Design File



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high-temperature metals . . .
think WAH CHANG

Tungsten, tantalum, molybdenum, columbium (niobium), hafnium, zirconium and their alloys . . . these are the versatile high-temperature metals that have helped make possible nuclear submarines . . . ballistic missiles . . . nuclear reactors . . . and innumerable other advanced applications and technical break throughs. These are the metals produced and fabricated under the strictest quality controls, extending from mine to market by Wah Chang Corporation . . . for over 41 years a leader in refractory metals.

Select the metal or alloy to fit your requirements for strength at high temperatures. Learn how these outstanding WCC high-temperature metals can improve your [illegible] applications.

For detailed information [illegible]

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Cb
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Zr

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ON THE MANTLE

ON CARPETING

ON THE PATIO

These eye-catching products use functionally a basic Nickeloid Metal. The finish of Chromium, Nickel, Brass or Copper is electroplated to a base metal, usually Steel (but often Zinc, Brass or Copper).

Mostly, Nickeloid Metals are supplied in continuous coils in widths up to 24" for modern, low cost fabrication. They're also available in sheets and strips. Optional: bright or satin finishes, plating one or both sides, a galaxy of stunning patterns and crimps.

Quality plating produces metals so durable they can be fabricated, even quite severely drawn or bent. Rejects minimized. For severe stamping, we offer Mar-Not protective coating that is easily peeled off after its job is done.

Which is your preference in modern metals — the clean, flint-hard gleam of Chromium, the warmth of Copper, or the rich radiance of polished Brass? No need to answer now, but consider the galaxy of wonderful products you find everywhere today that employ one of the Nickeloid Metals. These durable, lustrous finishes are not mere lily-gilding. In most instances they are designed INTO the product . . . functionally. We make a raw material that has been given these quality finishes the *automated* way . . . in giant coils in block-long mills. Nickeloid finishes are electroplated to the base metal *before fabrication,* a process as fundamental we believe as the coating of printing papers in rolls *before they are printed.* Three out of five costly manufacturing steps are by-passed. Write for our free Introductory Kit, which includes metal samples — learn the complete story.

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America's Pioneer Manufacturer of Pre-Finished Metals — Since 1898

PROPERTIES OF DAP COMPOUNDS

Type →	RX 1260	RX 1380
Impact Str (notched), ft-lb/in.	0.35	0.60
Flex Str, 1000 psi	8	15
Ten Str, 1000 psi	5	9
Compr Str, 1000 psi	25	30
Water Abs (48 hr), %	0.40	0.10
Heat Dist Point, F	320	525
Rockwell Hardness	M103	M110
Dielec Str, v/mil	300	450
Dielec Const	4.8	4.1
Dissip Factor	0.020	0.012
Vol Res, ohm-cm	4.7×10^{12}	5.0×10^{10}
Arc Res, sec	140	185

ability, particularly around metal inserts. The compound is recommended for electrical and electronic parts such as connectors, terminal boards, potentiometers and computer program boards. It meets requirements in specification MIL-M-14E.

KEY NO. 626

RX 1280 is a mineral-filled diallyl isophthalate molding compound that can be used at temperatures up to 500 F. The compound meets requirements in specification MIL-M-14F, Type MDG. It is not classed as flame resistant. **KEY NO. 627**

RX 1380 is a fiberglass-reinforced material in the isophthalic group. It has good resistance to temperatures up to 500 F and conforms to specification MIL-M-14F, Type SDG. It is said to have excellent electrical properties in the presence of moisture. **KEY NO. 628**

Synthetic Latexes Used on Fabrics

Three new synthetic latexes for use on fabrics have been introduced recently by Goodyear Tire & Rubber Co., Chemical Div., Akron 16, Ohio.

Pliolite 440 and Pliolite 460 are butadiene-styrene synthetic rubber latexes designed for textile and carpet backings, binders for nonwoven fabrics, scrim adhesives for carpets, and saturating and coating paper.

Both latexes have low viscosity. They are modified with carboxylics to provide better overall physical properties and faster, more economical curing. They also contain an

For more information, circle No. 419

Versatility
IN STAINLESS STEEL

. . . from highly accurate air-operated sanitary valves to unbelievably deep draws to specialty products, A-P-C versatility in drawing, welding and fabricating sets the pace for the stainless steel industry. Engineering know-how, manufacturing craftsmanship, increased production capacity provides you with components and parts far better and faster than ever.

A-P-C welcomes your investigation as the answer to all stainless steel requirements. Just a postcard brings a prompt reply.

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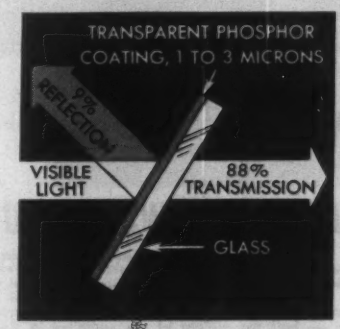


Excellent resolution capabilities for use in electronic projection applications

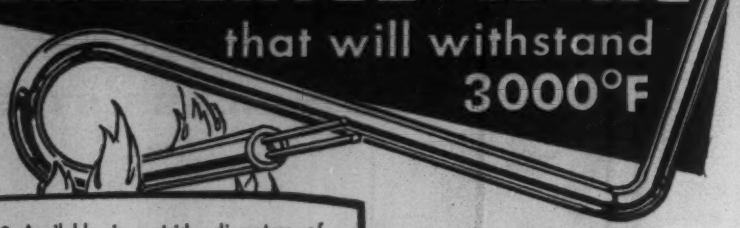
This vacuum-deposited coating developed by Liberty Mirror has a light output of 15 foot/lamberts or greater, at a power dissipation level of 25 milliwatts with peak output using a screen voltage up to 15 KV. It illuminates with extreme resolution.

Other vacuum-deposited coatings are used to make metallic first-surface mirrors, neutral filters, transparent mirrors, high-efficiency beam splitters, beam-splitting dichroic mirrors and filters. Metallic and transparent electrically conducting coatings are also available for resistance heating. Static-dissipating and high-frequency shielding coatings are also available.

Applied to glass, optical parts, metal, epoxy or plastic, the coatings are used in such varied products as toys, cameras, pin setters, wheel aligning equipment, aircraft and missiles. Liberty Mirror engineers will help you solve application problems. Technical data sheets are available on all coatings. Write L-O-F, Liberty Mirror Division, 2381 Libbey-Owens-Ford Building, Toledo 1, Ohio.

For more information, turn to Reader Service card, circle No. 333

INSULATED WIRE
that will withstand 3000°F



- Available in outside diameters of .025 to .313.
- One or more wires insulated from metallic sheath by a ceramic oxide.
- AerOPak can be bent and weldments performed without loss of insulation.
- Available in a variety of metal sheath materials, insulations and wires.

Ask for new revised issue of Bulletin 4. See VSMF—Reel F and Reel A.

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Heating Elements

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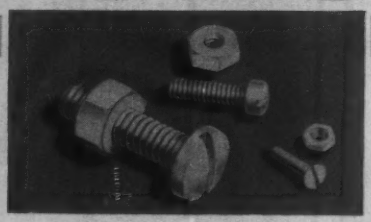
NEW NYLON & THERMO-PLASTIC PARTS from GRC



Economically mass produced on fully automatic patented machines, GRC nylon parts are available from stock in many sizes and types. GRC uses single cavity techniques, molds in one automatic cycle, gets accurate, uniform parts.

These advantages, these economies, apply too, to tiny made-to-order parts to your specifications . . . in quantities of 25,000 to many millions. Write for bulletin describing GRC's unique method for injection molding small plastic parts or send for prints for quotation. Ask about our zinc alloy die castings, too!

NO SIZE TOO SMALL
Maximum size 1¾" long—.05 oz.

NYLON SCREWS & NUTS

GRC's complete line of high quality, close tolerance molded nylon screws and hex nuts include screws in standard commercial heads — Phillips or slotted types — in sizes from #4 thru ¼"; hex nuts in ten sizes (#2 thru 5/16") GRC molded nylon miniature machine screws — half the weight of aluminum — in sizes as small as #0 — make more compact designs possible. GRC's single cavity molding technique adds exceptional uniformity, accuracy, economy to nylon's high strength-to-weight ratio, built-in electrical insulating qualities, stability, resilience and elasticity. GRC's molded fasteners are available in Nylon or Delrin, in a wide range of types, sizes and lengths.

WRITE, WIRE, PHONE NOW for Samples, Prices & your copy of GRC's new detailed Industrial Fastener Catalog

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25 years of progress in plastics

GRIES REPRODUCER CORP.
World's Foremost Producer of Small Die Castings
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antioxidant for better aging properties.

Chief difference between the two synthetics is that Pliolite 460 imparts more resinous properties which result in a stiffer body in the end product. **KEY NO. 629**

Pliolite VP-100 is a synthetic latex made from vinyl pyridine, styrene and butadiene. The new latex can be used as the main ingredient in fabric dipping compounds or blended with other synthetic latexes. It is said to provide improved adhesion between nylon and rayon fabrics and rubber and rubberized fabric materials.

KEY NO. 630

Paste Cleans, Primes Aluminum Surfaces

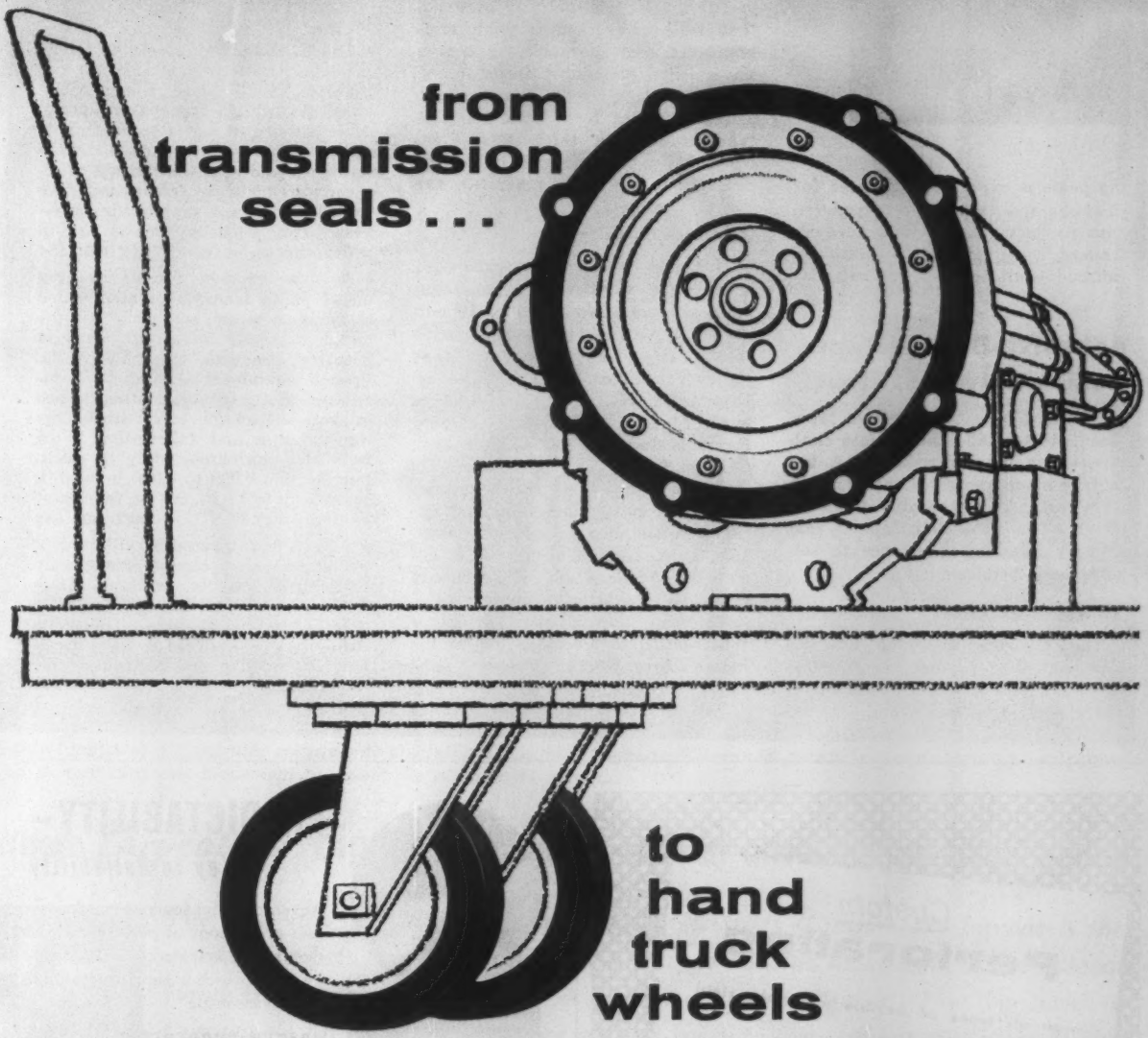
A combination cleaner and chemical surface treatment for aluminum is now available in developmental quantities from Hughson Chemical Co., Div. of Lord Mfg. Co., Erie, Pa. Called EX-B727-6, the material is sold as a translucent paste.

The paste is applied by spraying, wiping or brushing. After drying, the paste is rinsed off leaving a clean, prepared aluminum surface for bonding or coating. The developer says treated surfaces retain bonding properties for 12 months or longer without extra storage precautions.

Because of its ease of application,

***Translucent paste** is used to clean and treat this aluminum aircraft section in the field prior to painting.*

Your Firestone Technical Service Man shapes rubber compounds for everything . . .



Mulling over a design problem that calls for more than ordinary rubber? Your Firestone Technical Service Man compounds rubber for precision seals that stand up to oils and other solvents—for load-bearing industrial wheels that can't crack in cold weather—and for thousands of other special purposes. And he can engineer the rubber compound to fill *your* bill, whether it's for specific abrasion, corrosion, high or low temperature resistance or for a combination of requirements. Your Technical Service Man also creates rubber compounds that replace costlier materials. And Firestone's high-volume, high-accuracy production facilities are at your service, too, to carry the job right through to its final stage within strict cost limits. Details? Just fill out and mail the coupon—without obligation, of course.

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Firestone
Rubber & Latex Products Company
Fall River, Massachusetts

WITHOUT OBLIGATION, WE'D LIKE TO FIND OUT WHAT FIRESTONE'S TECHNICAL SERVICE MAN HAS TO OFFER US. FMR-FR31 (1)

Name and Title

Company

Product Manufactured

Address

City

State

FIRESTONE RUBBER & LATEX PRODUCTS CO.
Box 2290, Fall River, Mass.

For more information, turn to Reader Service card, circle No. 385

the paste is expected to be used for cleaning and treating large aluminum products in the field such as trailers, boats, aircraft sections and railroad equipment. KEY NO. 631

Adhesive-Backed Tapes Resist Solvents, Heat

Two new pressure sensitive tapes —an asbestos tape and a glass cloth tape—have been introduced. A big feature of the asbestos tape is that it withstands temperatures up to 900 F. The glass cloth tape is said to have excellent resistance to solvents and chemicals.

1. Asbestos tape

The pressure sensitive asbestos tape, called Besto-Tak, is supplied in commercial grades for use up to 500 F and in special grades for use up to 900 F. The tape is particularly useful in the assembly of products that will be exposed to high temperatures, such as mufflers and furnaces. It is available from Johns-Manville, Packings & Textile Div., 22 E. 40th St., New York 16. The tape is sold in thicknesses from 0.022 in. to ⅛ in. and in widths from ⅝ to 6 in. KEY NO. 632

2. Glass cloth tape

The glass cloth tape is backed with a pressure sensitive thermosetting resin adhesive that cures in 30 min at 350 F. Cure time is said to be considerably less than for other pressure sensitive glass cloth tapes. Designated No. 7020, the tape is available from Mystik Adhesive Products, Inc., 2635 N. Kildare Ave., Chicago 39.

The new tape is said to have high tack, high initial adhesion, and excellent resistance to solvents, abrasion, aging and chemicals. It is designed for Class 265 F (formerly Class B) operating temperatures.

The tape can be used in motor construction and repair, and in the manufacture of coils, relays, solenoids, transformers and other electrical equipment. KEY NO. 633

Other News . . .

Metals

▸ Coiled aluminum sheets are now available from Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19, with a transparent, strippable vinyl coating. The coating is said to protect the metal from scratches and surface damage often encountered during fabrication. The coated sheets are supplied in thicknesses from 0.016 to 0.051 in. and in widths up to 56 in. KEY NO. 634

▸ A new process for fabricating metal parts from preprinted coiled strip is now in operation at the metal stamping plant of Sylvania Electric Products Inc., York, Pa. Special equipment is used to accurately register two-color lithographed impressions on the coiled stock during printing and fabrication. Ferrous and nonferrous strip in thicknesses from 0.008 to 0.020 in. and in widths up to 15 in. can be fabricated by the process. KEY NO. 635

▸ A mill heat treated beryllium copper strip with a tensile strength up to 190,000 psi is available from Brush Beryllium Co., 5209 Euclid Ave., Cleveland 3, Ohio. The strip, called No. 190, is said to have excellent formability and a high degree of flatness. KEY NO. 636

▸ Standard bearing bronze bar stock

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—on all types of flexible materials, rigid sheets, and foam.

plastics
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in sheets and rolls up to 72" wide

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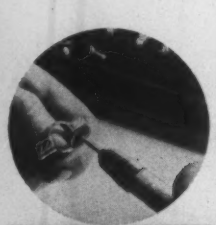
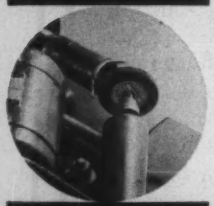

Cleaning and polishing small component parts, instruments and control mechanisms.


Breaking edges, shaping to slight radius, touching-up and scores of other operations.

Relieving stress concentration and blending-in to reduce danger of fatigue failure.

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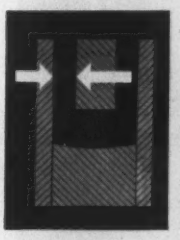
Control panel of a Carpenter consumable electrode (Consumet) furnace. Electronic circuits maintain positive arc control and precise electrode movement to assure the ultimate in refining.

Where *Carpenter's* "big inch" makes a mile of difference in alloy quality



The "big inch" in Carpenter's consumable electrode (Consumet®) furnace is the extra space between the consumable electrode and the mold wall. (Conventional furnaces of this type are almost ⅓ smaller at this vital point.) The "big inch" in Carpenter's furnace provides more exhaust space to carry off harmful gases. It also gives Carpenter technicians more precise vacuum control during the arc strike as well as during the entire melting process. As a result, you get cleaner, more uniform alloys from core to surface. Segregation and variation in grain size are minimized . . . to assure you consistent, predictable performance from your vacuum melted alloys. The "big inch" is only one of many exclusive Carpenter quality controls in consumable electrode, MEL-TROL® and vacuum-induction-melted (VacuMeltrol®) specialty steels. Ask your Carpenter representative for the full story behind these alloys and how they benefit you.

Carpenter steel

you can do it ***consistently*** better with Carpenter Specialty Steels for specialists

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Export Dept., Port Washington, N.Y.—"CARSTEELCO"
Alloy Tube Division, Union, N.J.
Webb Wire Division, North Brunswick, N.J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.

For more information, turn to Reader Service card, circle No. 370

from Bunting Brass and Bronze Co., 715 Spencer St., Toledo 1, Ohio is now being produced from continuous cast metal. Advantages are improved grain structure, higher physical properties, and a complete absence of foreign material. **KEY NO. 637**

Plastics & rubber

▸ An Orlon fiber-reinforced phenolic molding compound is said to provide good insulating properties, toughness, good chemical resistance and good mechanical stability. The compound, designated RX-745, molds well in thin sections at low pressures. It is available from Rogers Corp., Rogers, Conn. **KEY NO. 638**

▸ A new vinyl resin for making plastisols with unusually low fusion temperatures has been introduced by B. F. Goodrich Chemical Co., 3135 Euclid Ave., Cleveland 15, Ohio. Fusion temperature for plastisols based on the new resin is 300 F, compared to 350 F for plastisols based on other vinyl resins. Called Geon 135, the resin sells for 24¢ per lb in truckload lots. **KEY NO. 639**

▸ A glass cloth-epoxy laminate qualified to meet MIL-P-18177F specification is available from Swedlow, Inc., Box 2324, Youngstown 9, Ohio. The polyester-faced laminate is supplied as continuous sheets, strips and coils in thicknesses from 0.015 to 0.062 in. It is called Code X6G-280. **KEY NO. 640**

▸ A new silicone rubber compound for use as wire and cable insulation has been put on the market recently by the Silicone Products Dept. of General Electric Co., Waterford, N. Y. Called SE-9007, the material is designed primarily for high quality aircraft, hook-up, motor lead and similar wire applications. **KEY NO. 641**

▸ Two new heat reflective tapes for protecting cables, electronic equipment and other heat sensitive components have been introduced by Permacel, Inc., New Brunswick, N. J. No. EE 6100 is aluminum foil laminated to glass cloth with a pressure sensitive silicone adhesive on the glass side; No. EE 6101 has the same construction, but is non-adhesive. **KEY NO. 642**

Other nonmetallics

▸ A new type of glass for hermetic sealing applications has been introduced by Mansol Ceramics Co., Belleville, N. J. Identified as Comprex 40, the glass is said to have high torque characteristics, good wetting properties, good stability under extreme firing conditions, and good legibility for letter and number codes. **KEY NO. 643**

▸ Barium fluoride crystals doped with various rare earths and transition elements for laser applications are available from Semi-Elements, Inc., Saxonburg Blvd., Saxonburg, Pa. The crystals are ¾ in. in dia by 1 in. or more long. They sell for $400 each. **KEY NO. 644**

Finishes

▸ A new platinum electroplating solution has been introduced recently by Technic, Inc., P. O. Box 965, Providence, R. I. The solution, called TP, produces bright, pore-free deposits in thicknesses down to 0.0001 in. **KEY NO. 645**

▸ A new epoxy resin dip coating is said to provide a strongly adhesive surface coating with excellent moisture resistance on transformers, capacitors and similar parts. The coating, called Eccocoat D30, is available from Emerson & Cuming, Inc., Canton, Mass. The developer says that when preheated parts are dipped into the coating, the resin gels on the surface of the part and does not run or drip during oven cure. **KEY NO. 646**

Casting $1.18
Stamping...53
SAVED 65c
PER PART*

Originally this grey iron casting required expensive milling and drilling operations. In 350 lots the piece price was $1.18 plus pattern, milling fixture and drill jig charges.

*Converting to a stamping formed from 12 gage sheet steel cut the piece price to 53¢ including tooling. The present stamping is lighter, stronger, better duplicated and improved overall. Bulletin F-185 explains this highly efficient, specialized technique for cutting the work load and costs of metal fabricators. Write for it today.

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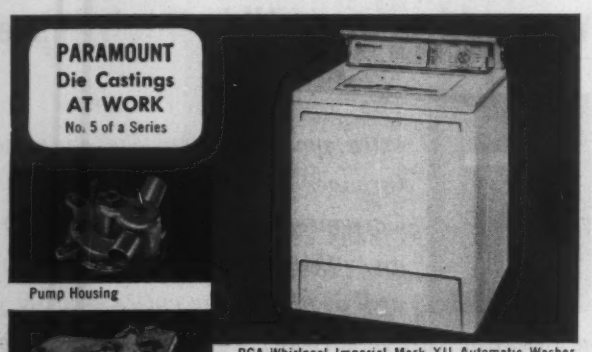
PARAMOUNT
Die Castings
AT WORK
No. 5 of a Series



RCA-Whirlpool Imperial Mark XII Automatic Washer

PARAMOUNT—a major supplier of die castings to Whirlpool Corporation for 15 years

Whirlpool quality is recognized throughout the world, quality which stems from the rigid quality standards which Whirlpool demands that its suppliers meet.

Paramount's engineering and production "know-how", its ability to consistently meet Whirlpool's exacting quality standards—as in these die castings for the RCA-Whirlpool Imperial Mark XII Automatic Washer—are the reasons why Paramount has consistently been one of Whirlpool's major suppliers for 15 years.

It Will Pay You To Look to Paramount . . .
If your product incorporates die castings or you're considering them—investigate Paramount's complete services.
Three complete plants—two in St. Joseph, Mich., one in Seymour, Indiana.

SEND For "Designing for Die Casting"

PARAMOUNT *Die Casting Co.*
(A subsidiary of TALON, INC.) ST. JOSEPH 5, MICHIGAN

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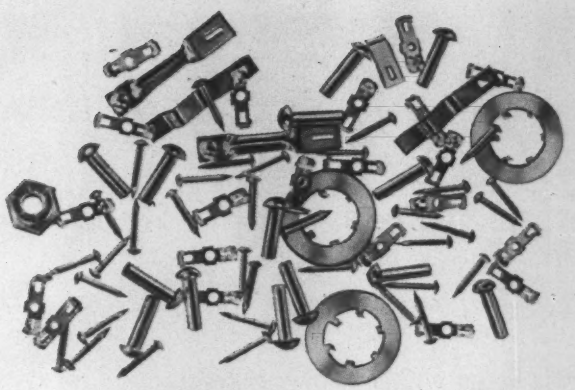

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The simplest, most efficient process for protecting electrical, electronic and lamp components with mirror-bright silver plating in flash to heavy deposits. Silva-Brite is a crystal-clear solution—work is visible during plating process. Plating is quick, easy, non-critical with results assured at current densities from 10 to 40 amps psf—and little or no polishing required. Normal room temperature operation minimizes fumes and bath decomposition. Write for complete information on Silva-Brite and application procedure.

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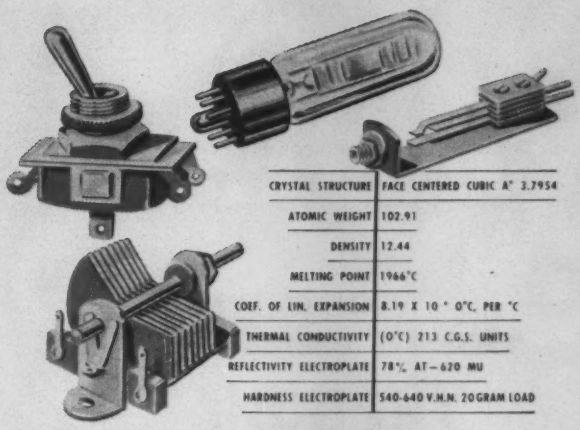

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THERMAL CONDUCTIVITY	(0°C) 213 C.G.S. UNITS
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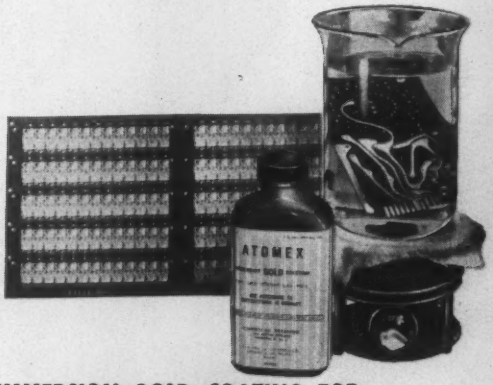

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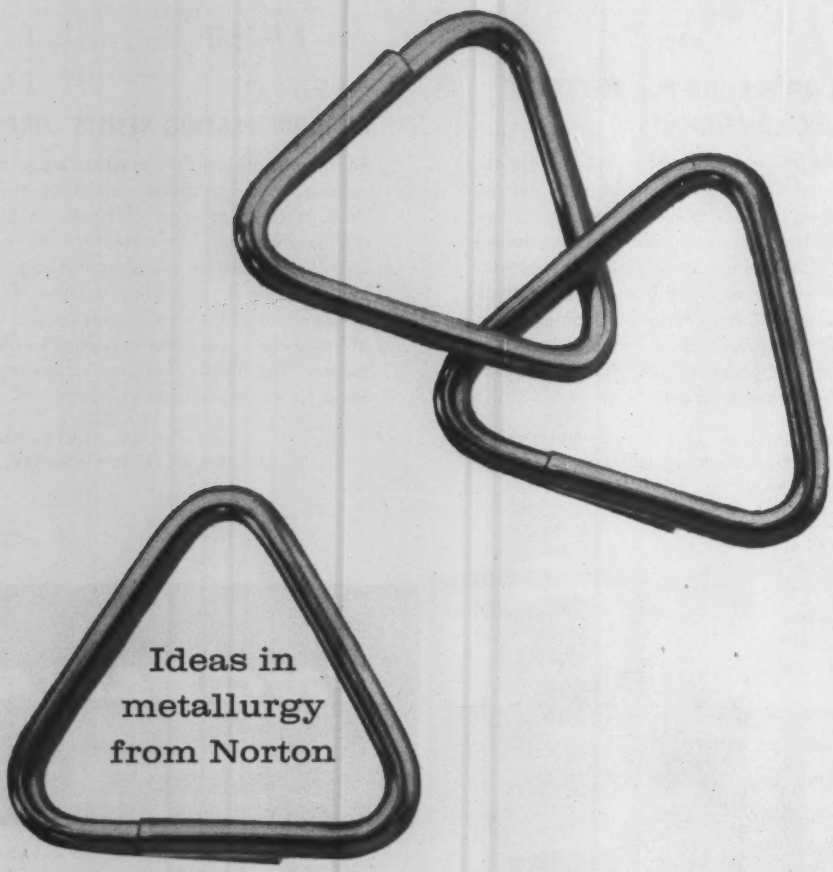

Metals are *born* in refractories. And most new ideas in metallurgy call for a new idea in refractory science . . . because a metal can be only as good as the refractory which contains it. Norton makes the finest.

The crucible of the reduction bomb, where uranium and plutonium burst into being, is a Norton product, pure magnesium oxide.

Another Norton material, fused stabilized zirconia, makes possible electric furnacing for processing tungsten and molybdenum, at temperatures up to 2200°C. Zirconia also lines huge pebble heaters and air furnaces in which metals for missiles are tested.

More super-alloys for missiles, submarines and space vehicles are possible through new vacuum melting techniques with high purity fused magnesia made by Norton. And in the aluminum industry, new efficiencies are being achieved with reduction cell linings of silicon carbide and cathode bars of titanium diboride.

In metallurgy as in other fields, Norton is crystallizing ideas into products to solve many problems . . . through oxide fusion and in probing experiments in carbides, nitrides and borides. Norton is ready to work with you in engineering materials to meet your needs. Write NORTON COMPANY, Refractories Division, 347 New Bond St., Worcester, Mass.

NORTON
REFRACTORIES
Crystallizing ideas into products

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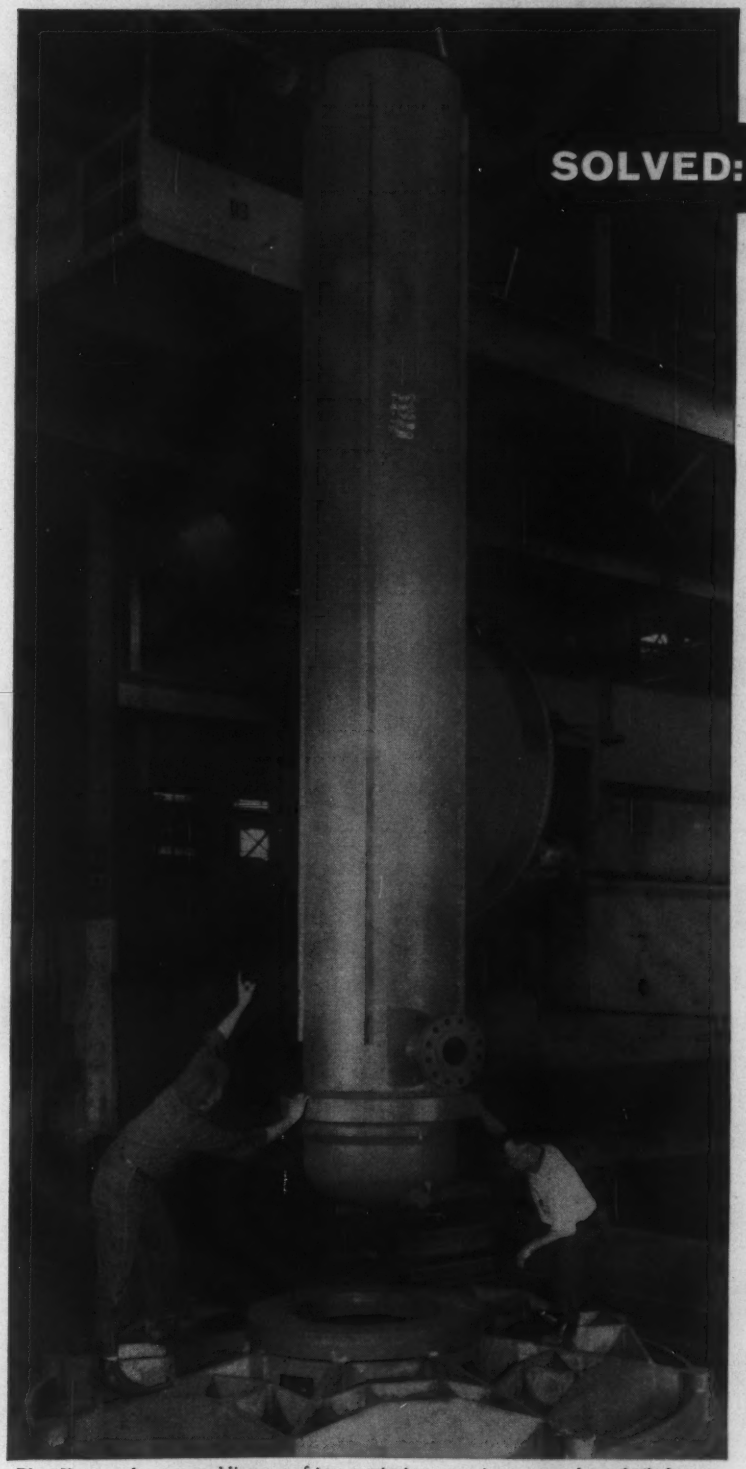

Blaw-Knox workmen assembling one of two constant pressure type accumulators built for two of America's largest steel mills. Sandusky supplied the straight cylindrical sections for both.

SOLVED: by Sandusky Centrifugal Casting

Blaw-Knox chooses 10-ton

SANDUSKY CASTING

for giant slabbing mill

When an 18½-foot cylinder was needed for a new giant Universal slabbing mill built by Blaw-Knox Company's East Chicago (Indiana) Works for a well known steel mill, they found that the most practical and economical way to meet all requirements was with a Sandusky Centrifugal Casting.

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"Only a dimensionally stable, one-piece cylinder could perform satisfactorily in this service," a Blaw-Knox official asserted. *"Distortion could lead to binding, loss of pressure and costly downtime. Sandusky's ability to produce this heavy walled cylinder in one 18½ foot length met all our requirements of cost, stability, and strength."*

Sandusky cylinders up to 33 feet long —from 7" to 54" O.D.— and in a wide range of ferrous and non-ferrous alloys —may well be the answer to *your cylindrical problems,* too.

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FOUNDRY & MACHINE CO.

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

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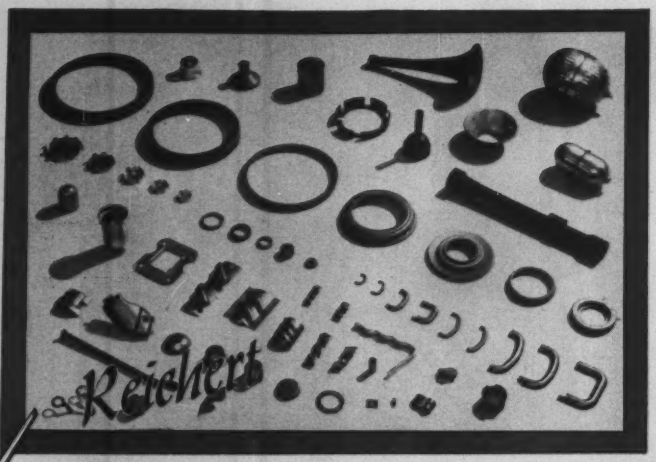

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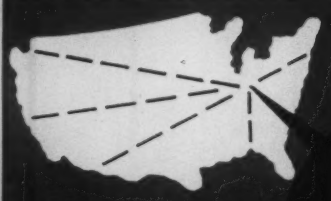
FROM AROUND THE NATION



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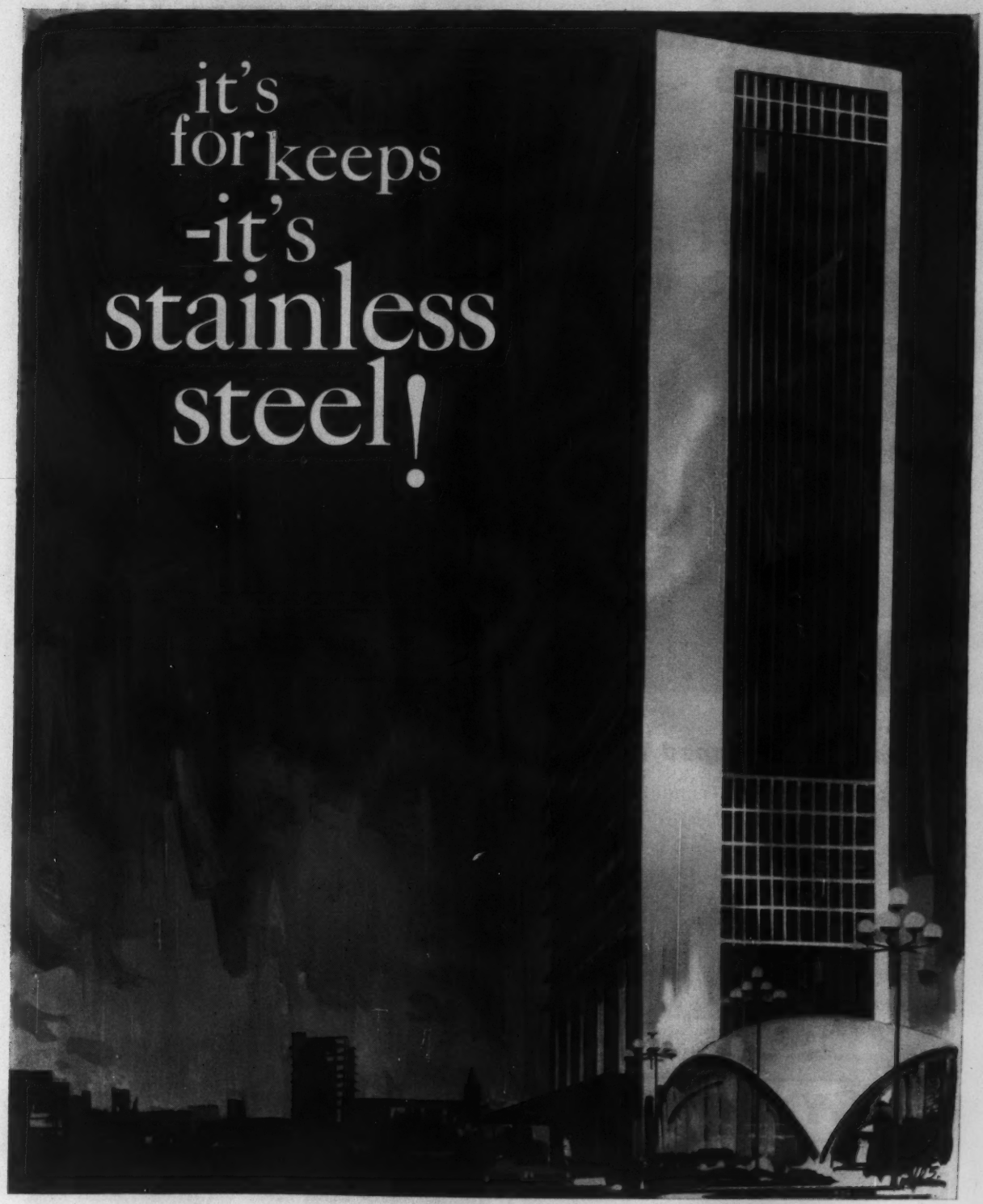

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McLouth Steel Corporation, Detroit 17, Michigan

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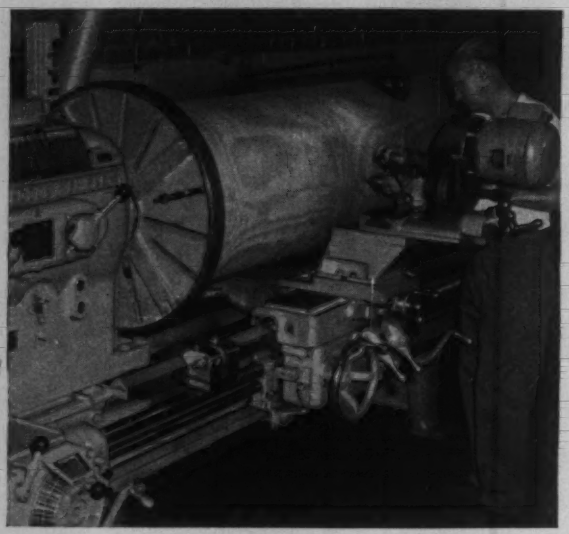
1001 Ways to Machine Laminated Plastics



An Example of Synthane *You-shaped* Versatility

There are many fast, economical ways to machine laminated plastics—if you have the equipment to do the job. We have! Synthane is just about tops in U. S. for plastics fabrication. That's our business. We have all the standard tools plus many machines designed especially for the fabrication of laminated plastics. Why bother to improvise when we have what it takes to do the job—quickly and economically.

You-shaped Versatility makes Synthane a Better Buy in Laminates

SYNTHANE
CORPORATION OAKS, PENNA.

Synthane Corporation, 3 River Rd., Oaks, Pa.
Gentlemen:
Please send me information regarding the facilities of Synthane for fabricating laminated plastic.

Name_____

Address_____

City_____ Zone____ State_____

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Tungsten
Molybdenum
Tantalum
and
Others

NOW—for the first time

FABRICATED - WELDED - MACHINED

Super-Temp Eng. & Mfg., Inc. now can offer **complete fabrication** of light or heavy sheet of pure tungsten, molybdenum, tantalum-tungsten and other high temperature metals into almost any shape desired for missiles, space and re-entry vehicles.

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Die Forming—Spinning
Flame Spraying—Bonding
Engineering—Assemblies

PART APPLICATIONS
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Super-Temp Eng. & Mfg., Inc.

2024 W. 15th St., Long Beach 13, Calif.
Phones—HEmlock 6-9236 . . SPruce 5-1600

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WE FABRICATE IN MORE THAN

200

DIFFERENT MATERIALS!*

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SEALS SHIMS BUSHINGS "O" RINGS

If it's a problem of the right material for the job—at the right price—Auburn is sure to have the perfect solution among the wide range of materials in which we work.

Put our 87 years experience to work for you—Auburn's engineers are tops in their field in designing and fabricating precision sealing devices. Their know-how is at your command. "O" Rings are a speciality with us.

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Cork · Fibre · Compositions · Phenolics · Cloth · Felt · Paper · Cardboard · Plastics
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301 Stack St., Middletown, Conn.

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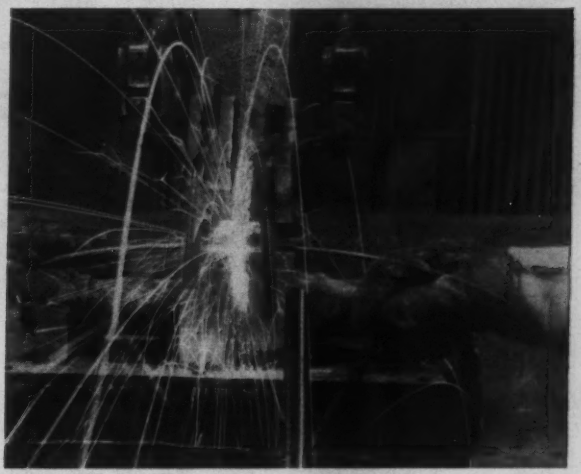
Here's how Bethlehem Wire in heavyweight coils cuts your costs

Bethlehem heavyweight coils, with from 1,000 to 2,000 lb of wire in one continuous length, offer these cost-cutting advantages:

REDUCED MACHINE DOWN-TIME—By using the heavyweight coil, instead of 13 150-lb catchweight coils, you save a maximum of 12 costly machine shutdowns necessary every time you start a standard size coil.



LESS BUTT-WELDING AND COIL REMNANT SCRAP—In operations requiring the welding of coil ends, the time and cost of butt-welding is reduced. And there's less waste in the form of coil remnant scrap.

NO DEPOSITS . . . NO RETURNS—Returnable carriers are not needed with Bethlehem heavyweight coils. Carriers take up valuable storage space, involve extra paperwork, and tie up your cash.

MINIMIZED HANDLING COSTS—One man, operating a fork-lift, crane, or ram truck, can easily handle a heavyweight coil. Speedy unloading. Efficient stacking.

BUNDLED THE WAY YOU WANT THEM—We can supply our heavyweight coils with or without a pallet, for use on welded steel cores (rotating or stationary payoff).

Want more information? Get in touch with our nearest sales office. Or write to us at Bethlehem, Pa.

Steel *for Strength . . . Economy . . . Versatility*

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

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M. Randolph Long, *Advertising Sales Manager*

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For more complete information, and application data on their lines, refer to the index of Advertisers in the Mid-November MATERIALS SELECTOR ISSUE of MATERIALS IN DESIGN ENGINEERING.

The last word

by H. R. Clauser, editor

NEEDED: 2.5 million of us by 1970

By 1970 this country will have a million more engineers and scientists than it does now. And we will be spending two to three times as much on basic research and technical education as we do now.

We will, that is, if we want to advance technologically at the rate we must to stay free and maintain a high standard of living.

These are the estimates made by men who, in the last two years, have been charting the course for a national policy to insure our technological progress. The direction of the government's current approach was set late last year in "Scientific Progress, the Universities and the Federal Government," issued by the President's Science Advisory Committee. The facts and figures are documented in the report, "Investing in Scientific Progress," just published recently by the National Science Foundation.

In all likelihood, our national science and engineering effort in the decade ahead will be largely guided by the goals established and the policies laid down in these two major policy documents. Therefore, it would be wise for all of us to familiarize ourselves with at least the essence of these reports.

More Men, More Money

First of all, what must we do to insure the needed expansion in science and technology? Above all, the reports say, we must effectively identify, develop and utilize our engineering and scientific talent. The number of professional engineers and scientists must nearly double in the next ten years—from 1,400,000 in 1960 to 2,500,000 in 1970. Therefore, every young person who shows the desire and capacity to become a scientist or engineer must be ensured an opportunity to do so. And, to provide this opportunity for technical education, we will need more teachers, buildings and facilities. The annual cost: $5.5 billions in 1970 as compared to $2.1 billions in 1961.

Along with increased emphasis on technical education, we must also raise our sights on basic research. In the universities alone, the money spent on basic research by 1970 must be three times that spent in 1961.

Who Picks Up the Tab?

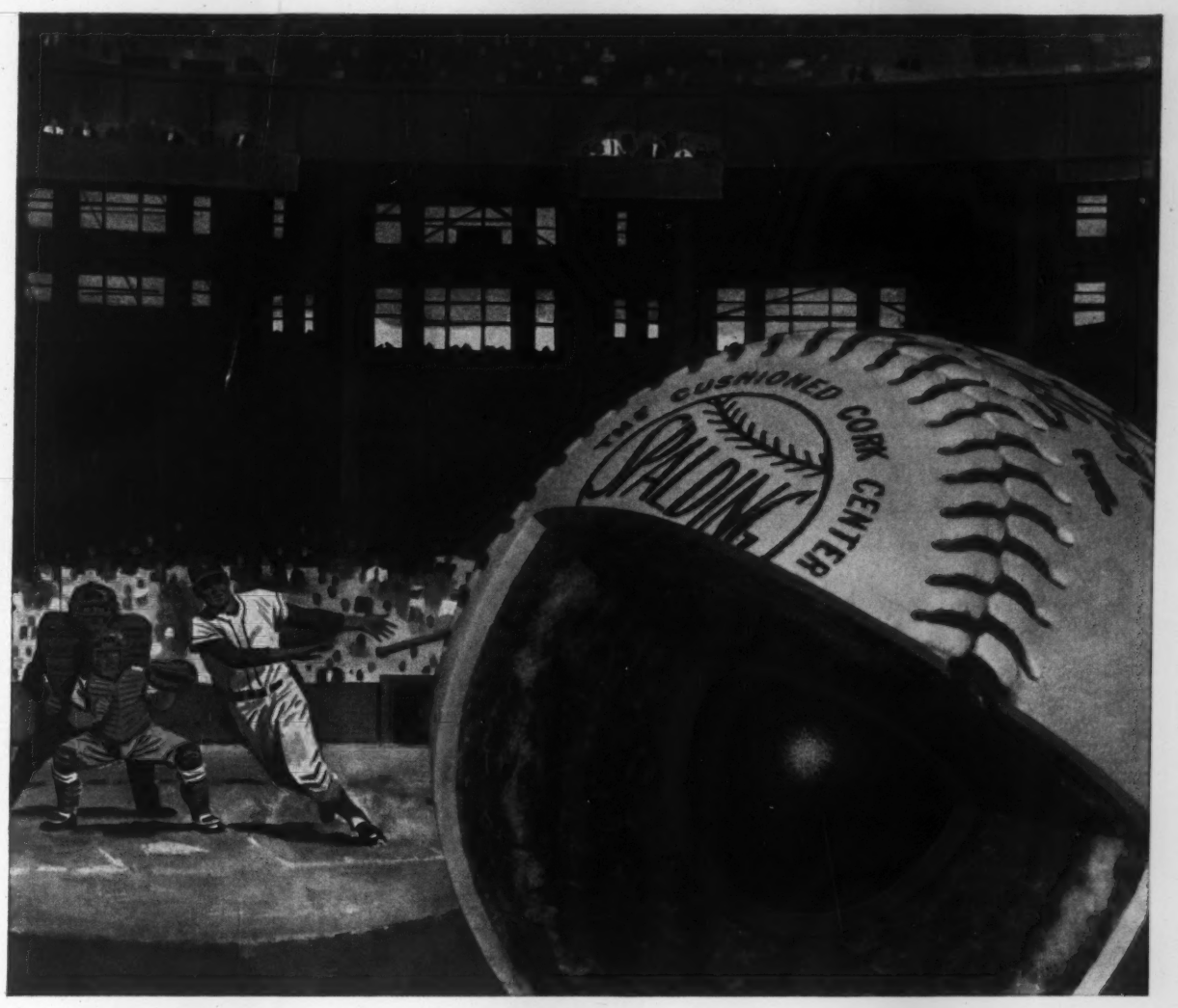
What then is our national policy to achieve these goals? Where will the money come from and who will have the major responsibility for education and for basic research?

There seem to be two answers: First, the Federal Government must assume increased support of research and education. Today, the Federal Government provides 60% of the funds spent for basic research. In the coming years this figure must rise.

Second, the major responsibility for achieving the goals in basic research and education rests on the partnership between the universities and the national government. The President's Science Advisory Committee says: "The partnership is a fact. It has done much more good than harm. It seems certain to grow in importance unless the American people decide to accept a second-rate standing in terms of power, of comfort, and of knowledge. The broad problem which faces the government and the universities is to make the partnership fully fruitful."

An Investment in Civilization

These, then, are the goals and plans that represent the nation's investment in science and engineering during the next decade. As the NSF report concluded: "Our past investment in science has brought us double reward: a highly developed technology which has helped to keep us free, and a continuing enlargement of our understanding which has helped to enrich our freedom. Today, far more than in the past, scientific progress determines the character of tomorrow's civilization."



Ameripol Rubber plays undercover role for Spalding

At the core of each Spalding-made Major League baseball is a "cushioned cork center" covered with a quarter-inch layer of Ameripol Rubber.

More important than the amount of rubber used are the rigid requirements for constant quality. The center must be perfect in every way, with uniform resilience from ball to ball.

Indicative of Spalding's quality control is the fact that balls are wound in a sealed room where temperature and humidity are held uniform at all times. This all helps insure that each ball meets Official Major League specifications.

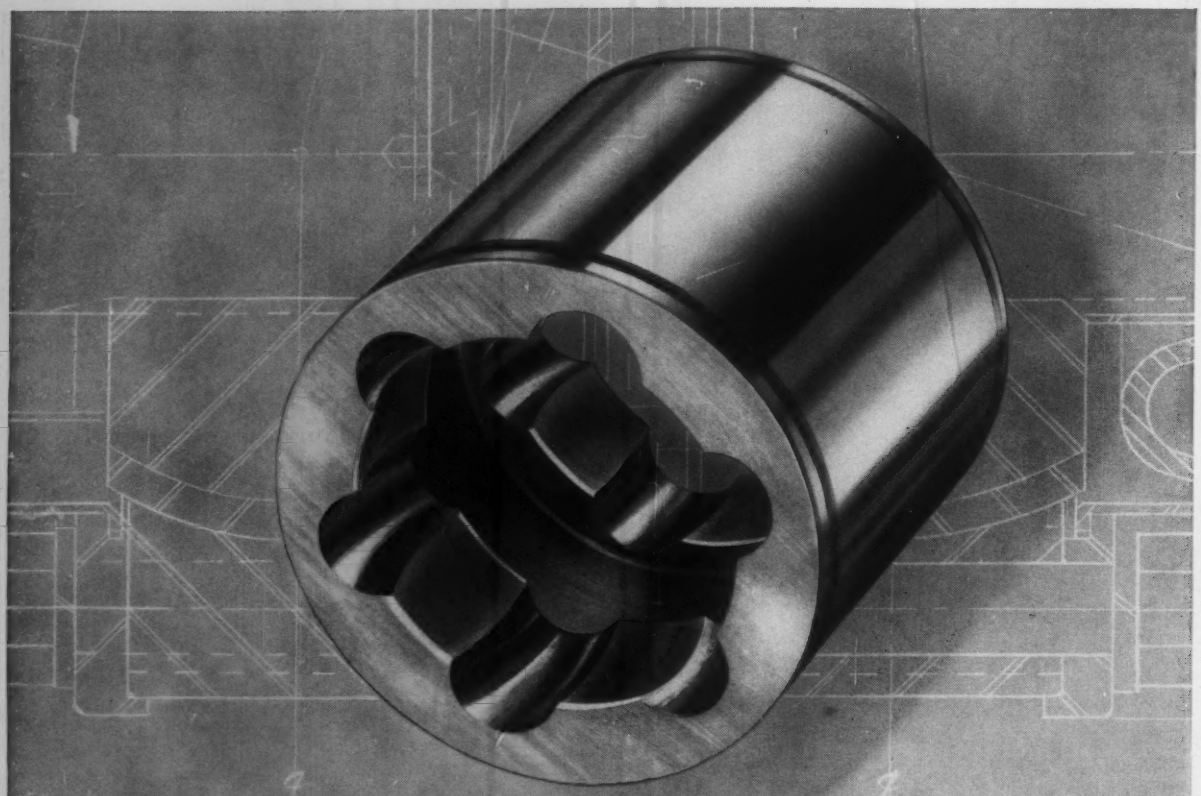
If high quality is important in *your* rubber products, check with Goodrich-Gulf. From production research and quality control, to technical service and warehousing, we're organized to meet your needs. For information contact Goodrich-Gulf Chemicals, Inc., 1717 East Ninth Street, Cleveland 14, Ohio.

Ameripol
THE PREFERRED RUBBER

Goodrich-Gulf Chemicals, Inc.

WORLD'S LARGEST SOURCE OF SYNTHETIC RUBBER

For more information, turn to Reader Service card, circle No. 410



How Dana cut cost but not quality of universal joint

Before the development of the constant velocity universal joint, transmitting uniform rotary motion through a varying angle from shaft to shaft was unsatisfactory at best. Now this type of joint has hundreds of successful applications, including marine and aircraft, road building and mining machines, and machine tools. And with Dana Corporation's Con-Vel Division Rzeppa universal joints, motion transmission is virtually vibration-free. Their disc-type double joint, made from two forged and machined single units coupled together, had one probem—high manufacturing cost. Dana wanted to reduce this cost while maintaining quality.

After consulting with Timken Company metallurgists, Dana redesigned and switched to Timken® seamless steel mechanical tubing for the double outer race of the disc. Savings were immediate and sizable. With the tubing, there's no hole to drill, less machining. Quality was maintained and strength actually increased because of the fine forged quality of Timken rotary-pierced tubing.

Find out how versatile Timken seamless steel tubing—targeted during manufacture to your end use—can save you time and money on your hollow parts. Write: The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

TIMKEN®
***Fine Alloy* STEEL**

TIMKEN ALLOY STEEL AND SEAMLESS STEEL TUBING ARE AVAILABLE FROM STEEL SERVICE CENTERS IN 44 CITIES IN THE UNITED STATES

For more information, turn to Reader Service card, circle No. 328